MAINTENANCE MANUAL

STEAM GENERATORS

- LBAS Series - Integral (Non-solid State)
- LBAS Series - Integral (Solid State)
- LB Series - Stand Alone
- CHS Series - Integral
- CES Series - Stand Alone

(08/30/02) **P750708-091**

A Word From STERIS Corporation

IMPORTANT

The operation and maintenance procedures recommended by STERIS® are described in this manual. Only these recommended maintenance procedures should be followed.

A listing of the safety precautions to be observed when operating and servicing this equipment is in Section 1 of this manual. Do not operate or service this equipment until you have become familiar with this information.

Any alteration of this equipment not authorized or performed by STERIS Engineering Service which could affect its operation will void the warranty, could adversely affect sterilization efficacy, could violate federal, state, and local regulations, and could jeopardize your insurance coverage.

INDICATIONS FOR USE

STERIS® Electric Steam Generators provide the high-quality (97 percent vapor quality) steam needed to power equipment such as sterilizers, water stills, utensil sanitizers, and water temperature boosters for washing equipment. They provide a steam source when in-house supply is not available, when an empty emergency standby is required, or when a remote location needs to be served.

When a deionized, distilled, or reverse osmosis water supply (minimum resistivity of 1 megohom/cm) is available, stainless-steel generators can also be used to supply pure steam.

SERVICE INFORMATION

A thorough preventive maintenance program is essential to safe and proper equipment operation. This manual contains maintenance schedules and procedures which should be followed for satisfactory equipment performance.

You are encouraged to contact STERIS concerning our comprehensive Preventive Maintenance Agreement. Under the terms of this agreement, preventive maintenance, adjustments, and replacements of worn parts are done on a scheduled basis to assure equipment performance at peak capability and to help avoid untimely or costly interruptions. STERIS maintains a worldwide staff of well-equipped, factory-trained technicians to provide this service, as well as expert repair services. Please contact STERIS for details.

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The base language of this document is ENGLISH. Any translations must be made from the base language document.

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Section 1: Listing of Safety Precautions

The following is a listing of safety precautions which must be observed when operating or servicing this equipment. WARNINGS indicate the potential for danger to personnel, and CAUTIONS indicate the potential for damage to equipment. These precautions are repeated (in whole or in part), where applicable, throughout the manual.

Observance of these safety precautions will minimize the risk of personal injury and/or the possible use of improper maintenance methods which may damage the unit or render it unsafe. It is important to understand that these precautions are not exhaustive. STERIS® could not possibly know, evaluate, and advise maintenance departments of all conceivable ways in which maintenance might be done or the possible hazardous consequences of each way.

WARNING – ELECTRIC SHOCK AND BURN HAZARD:

Voltages normally present in the steam generator are dangerous and may be fatal if contacted. Use extreme care when making voltage and current measurements on live circuits.

Voltages and steam pressures normally encountered in the steam generator are potentially dangerous. Always take the following precautions: (1) Allow the steam pressure to drop to zero and the unit to cool. (2) Completely disconnect the unit from power source before beginning any repair or replacement of components.

Do not insert fuses in live circuits. Voltages present in the steam generator are dangerous and may be fatal if contacted.

Disconnect electrical power at source before servicing generator to avoid personal injury or death.

Allow boiler to cool and pressure to drop to zero before servicing.

Retorquing should be done when unit is cold and with power disconnected at source.

A qualified individual must effectively ground any installation involving electric heaters in accordance with the National Electrical Code.

Hazard of electrical shock and severe burn; Injury or death may occur if this equipment is not properly installed and operated. The boiler must be grounded using the grounding means proviced and be wired in accordance with the National Electrical Code by a qualified person after reviewing the installation and operating instructions for your electric steam boiler.

WARNING – BURN HAZARD

Use care when opening the petcock to avoid burns from hot water.

Some parts of this equipment are hot. Always wear protective clothing, gloves, and eye protection when operating this equipment.

During this procedure, the boiler piping is hot and water is released under pressure and should be connected to a receiver capable of withstanding 260°F (127°C). To prevent burns, wear protective gear and use caution.

Steam and boiling hot water will exit the drain under pressure. Proper safety attire (gloves, eye protection, insulated overall) are necessary.

WARNING – PERSONAL INJURY HAZARD

Verify that generator pressure gauge indicates “O” psig before proceeding.

CAUTION – POSSIBLE EQUIPMENT DAMAGE:

Do not use power tools or chipping motion when cleaning heating element as this may damage the element tube wall.

Do not alter the setting of the four adjustment screws shown in Figure 6-1. The setting of these screws is critical, since improper adjustment could damage the generator. Normally, the screws will not require readjustment if the original factory setting is not disturbed.

Do not attempt to correct incorrect switching by rotating the adjustment screws until absolutely sure that lead position and switch mounting are correct. If readjustment is necessary, rotate the applicable adjustment screw in the direction required, as indicated in Table 6-1, and check for proper switching. Alternately adjust and check unit switching at the levels shown in Figure 6-2.

Provision should be made to prevent water damage from any eventual leaking of boiler or components. Install near a floor drain.

Shut off steam supply and hot water supply lines before proceeding with installation.

Use liquid detergent only. Water soluble powders may clog steam gun.

Section 2: General Information

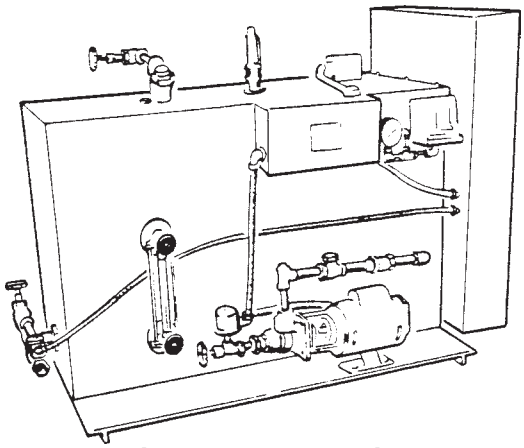


Figure 2-1. LB Series (Stand-alone)

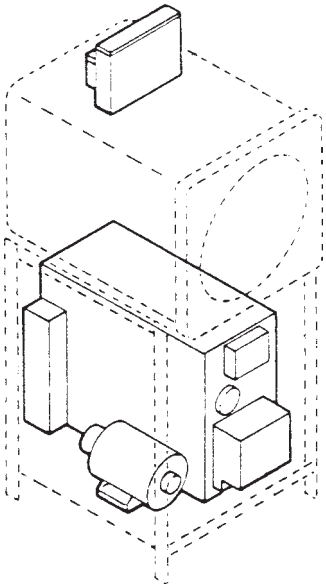


Figure 2-2. LB15/20AS Series – Non-solid State (Integral)

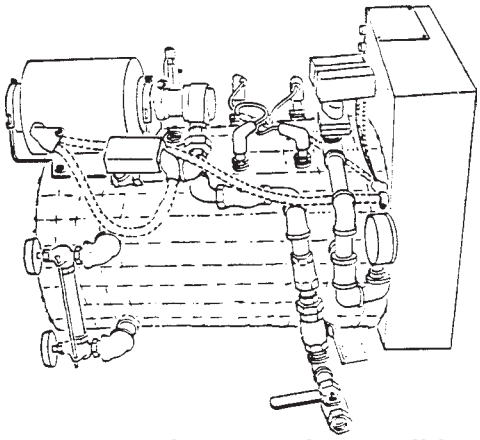


Figure 2-3. LB20/30AS Series – Solid State (Integral)

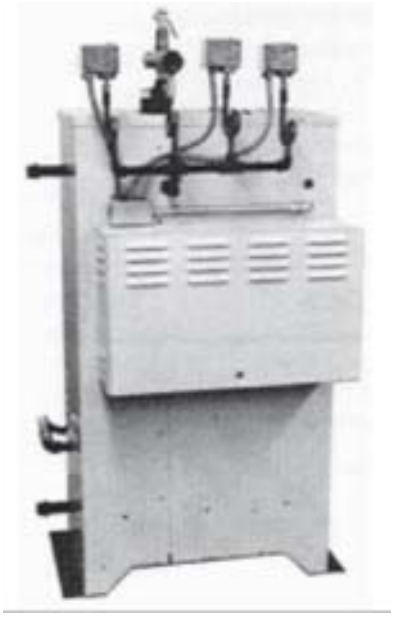


Figure 2-4. CES Series (CH02/CH14) (10 KW/180 KW)

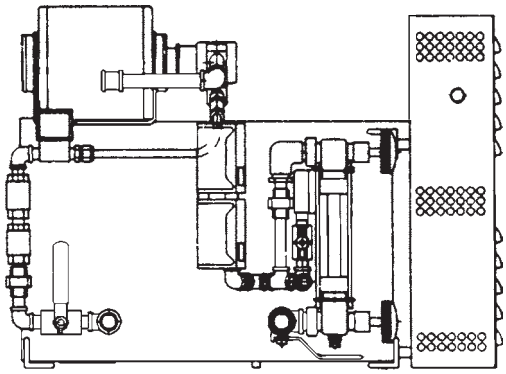


Figure 2-5. CHS/AS Series

2.0 SCOPE OF MAINTENANCE MANUAL

This manual provides information necessary for operation, preventive maintenance, troubleshooting, and repair of the STERIS Electric-steam generators. Information is presented generally for five categories of generators:

- LBAS Series - Integral (Non-solid State)
- LBAS Series - Integral (Solid State)
- LB Series - Stand Alone
- CHS Series - Integral
- CES Series - Stand Alone

Installation and operator information is described in Section 3. Many maintenance and repair procedures described in this manual are intended for use by qualified personnel only. Therefore, it is recommended that procedures which require special skills be performed by qualified personnel only.

2.1 DESCRIPTION

2.1.1 General

STERIS electric-steam generators basically consist of a water type boiler fired by a submerged electrical heating element. Automatic controls maintain preset operating pressures and keep the water supply at the proper level in the boiler. Safety features include:

- automatic low-water cutoff,
- automatic pressure control,
- safety valve, and
- a visible water level sight gauge.

The entire unit, built in accordance with the A.S.M.E. Miniature Boiler Code, is individually inspected and stamped by an authorized national board insurance inspector, and approved and listed by both Underwriters Laboratories and The Canadian Standards Association.

2.1.2 LB Series (Figure 2-1)

The LB Series of Electro-Steam generators includes 11 models (10-, 15-, 20-, 30-, 40-, 60, 80-, 100-, 120-, l50-, and l80-KW). Models 10 KW through 60 KW contain two chambers: one for the heater element and another for steam. These two chambers are connected by manifolds. 80 KW and larger units have one chamber. The boiler section is insulated with aluminum-backed fiberglass and are enclosed in a metal cabinet. Units may incorporate automatic flushing to help ensure trouble-free operation. All LB Series units are high-pressure generators incorporating a water pump, and can supply steam pressures from 0 to 90 psig.

2.1.3 LB15/20AS Series - Non-Solid State (Figure 2-2)

The LB15AS or LB20AS Series (Non-solid State) is identical to the LB Series except that electrical contacts are located on top of the sterilizer instead of at the front of the generator. This unit was designed to mount under 16" or 20" Medallion X, Medallion, and early Eagle 2000 steam sterilizers.

2.1.4 LB20/30AS Series - Solid State (Figure 2-3)

The LB20AS or LB30AS Series (Solid State) was designed to mount under a 16" or 20" Eagle 2000, and Eagle 3000 Stage 2 Series steam sterilizers.

2.1.5 CES Series (CH02/CH14) (10 kW to 180 kW) (Figure 2-4)

The CES Series includes 11 models (10, 15, 20, 30, 40, 60, 80, 100, 120, 150, and 180 kW). The chamber is a vertical tube with heater elements mounted perpendicular to the chamber. Boiler section uses aluminum-backed fiberglass insulation and is enclosed in a metal cabinet. All units include water pump for high-pressure operation (up to 90 psig). Current models include antiflood control with a solenod valve on the steam outlet piping.

2.1.6 CHS/AS Series (Figure 2-5)

The CHS series includes three models (20, 30, and 45 kw). The chamber is a horizontal tube with heater elements mounted parallel to the chamber. Boiler section uses aluminum-backed fiberglass insulation. All units include water pump for high-pressure operation (up to 90 psig); models include antiflood control.

2.2 OPERATION OF GENERATORS - LB AND LBAS MODELS (FIGURE 3-1)

2.2.1 LB Series without Automatic Flush

a. Close the steam outlet valve.

b. Open the water-level sight glass valves if they are closed.

c. Open the drain valve at the rear of the unit and the drain valve on the water-level sight glass.

d. Operate the main electric power disconnect switch to ON. (The main disconnect switch is not part of the generator and is not shown in Figure 3-1.) Water will flow into the generator and out of the drain valves, flushing out the boiler. Allow the unit to flush for at least three minutes, then close the drain valves. The generator will automatically fill to the proper working level and then start to heat.

e. When the generator has reached proper operating pressure, slowly open the steam outlet valve. Opening speed should not be less than one minute to open the valve two turns.

2.2.2 LB Series with automatic flushing drain valves

a. Close the steam outlet valve and manual drain valve.

b. Open the water-level sight glass valves if they are closed.

c. Open the water-level sight glass drain valve.

d. Operate the main electric power disconnect switch to ON. (The main disconnect switch is not part of the generator and is not shown in Figure 3-1.)

e. Operate the pilot toggle switch to the ON position. The steam generator will automatically flush for three minutes.

f. Close the water sight glass drain valve.

g. Unit will automatically fill to proper level and start to heat.

h. When the generator has reached proper operating pressure (within 10 minutes after flushing), slowly open the steam outlet valve. Opening speed should not be less than one minute to open the valve two turns.

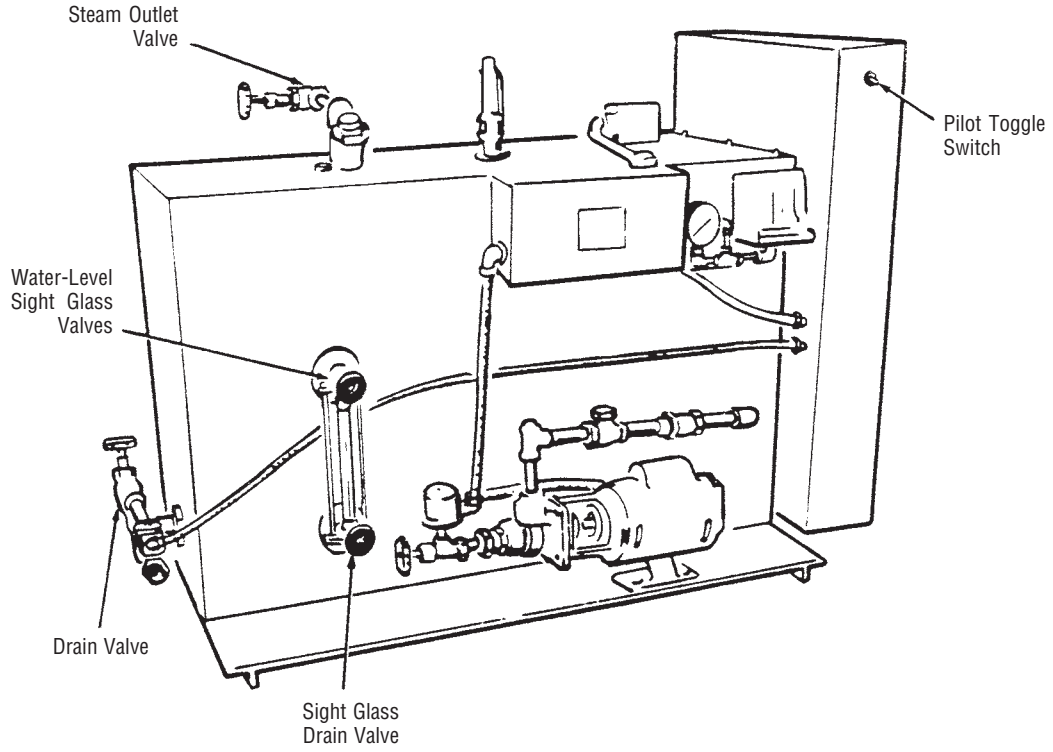


Figure 2-6. Operator Controls for LB Series Steam Generator

2.2.3 LBAS Series Integral Units

LBAS generators are tied directly into the sterilizer control. Turning on the sterilizer automatically turns on the electric steam generator. No additional operator input is necessary. Refer to the sterilizer equipment manual for further information.

2.2.4 Stopping Steam Generator

2.2.4.1 LB Series:

a. Set the pilot toggle switch on the generator to the OFF position.

NOTE: During normal operations, units equipped with automatic flushing must always be turned off by the ON-OFF pilot toggle switch on the side of the generator electric panel. Do not turn off the unit by the main electric disconnect switch. If it becomes necessary to turn off the main electric disconnect switch for servicing, first place the pilot toggle switch in the OFF position. After the pilot toggle switch has been turned off for at least three minutes, the main electric disconnect switch can be turned off. This will allow the timer to reset and get into position for the next starting cycle.

b. Allow the generator to cool and the pressure to drop to zero; then close the steam outlet valve in preparation for the next period of operation.

2.2.4.2 LBAS Series:

Turning off the sterilizer control automatically turns off the steam generator. No additional operator input is necessary. Refer to the sterilizer equipment manual for further information.

2.3 OPERATION OF GENERATORS - CES AND CHS MODELS

2.3.1 CES Models Figure 2-4

a. Close the globe valve on steam outlet side of boiler.

b. Turn on boiler and allow pressure to build up to operating pressure.

c. Only open the globe valve at quarter turns at first, introducing smaller amounts of steam into the process. Avoid opening globe valves all at once. This will eliminate the possibility of evacuating the boiler of water caused by the suddenly increased boiling of the water in the vessel as the pressure is reduced. On boilers where constant pressure is not maintained, globe valve should be kept partially closed. This will maintain a constant head on the boiler and help stabilize any fluctuation in boiler water level.

d. Check for leaks in piping; repair as necessary.

e. If you have been supplied with a Manual Reset Low Water control as required in some states, the reset button on the control must be pushed before boiler will begin developing pressure. Do not push reset until boiler has filled with water.

2.3.2 CHS Models

CHS models are tied directly into the sterilizer control. Turning on the sterilizer automatically turns on the electric steam generator. No additional operator input is necessary. Refer to the sterilizer equipment manual for further information.

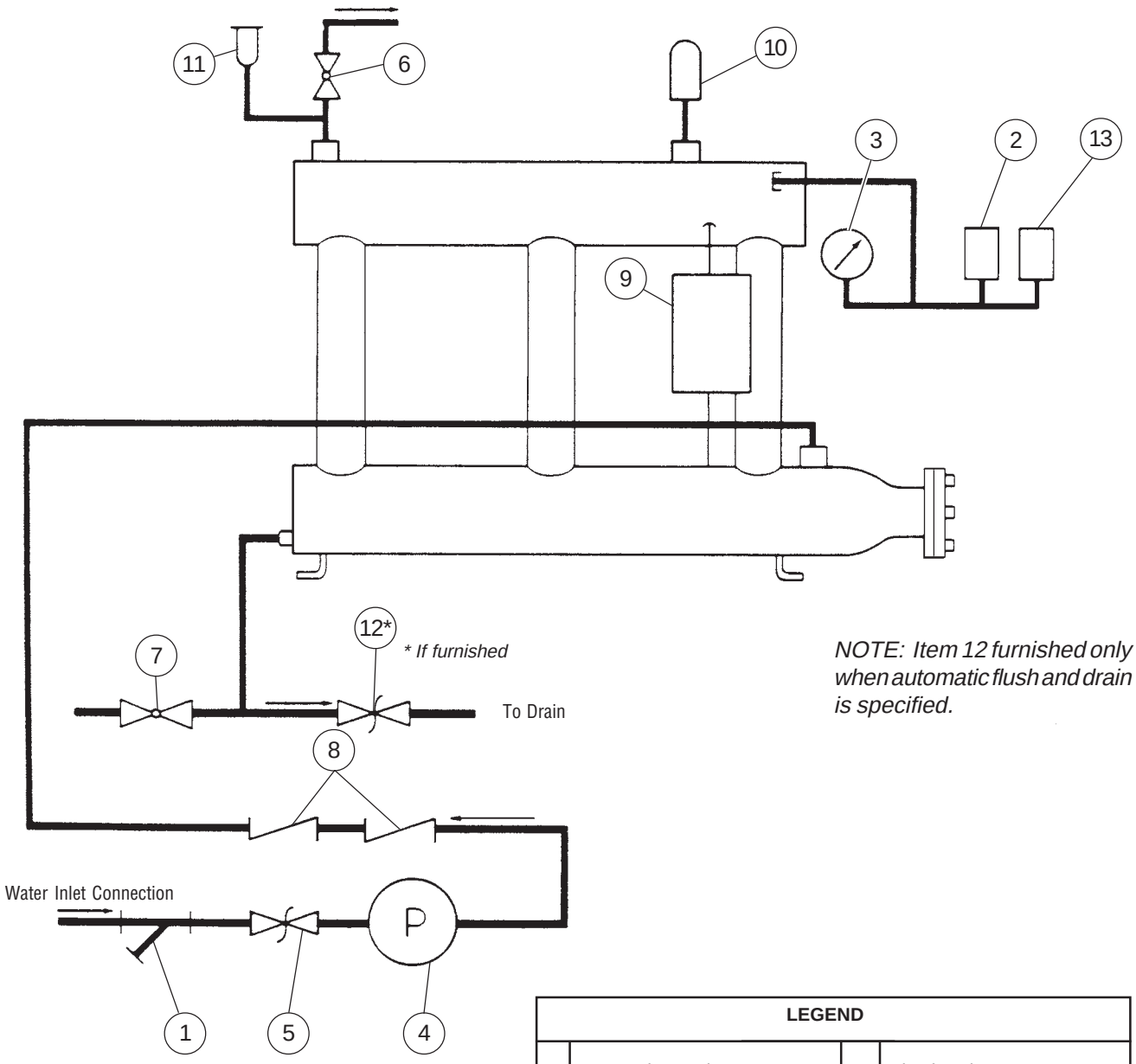
2.3.3 Stopping Steam Generator

2.3.3.1 CES Models

a. Turn off power at boiler using boiler power switch.

2.3.3.2 CHS Models

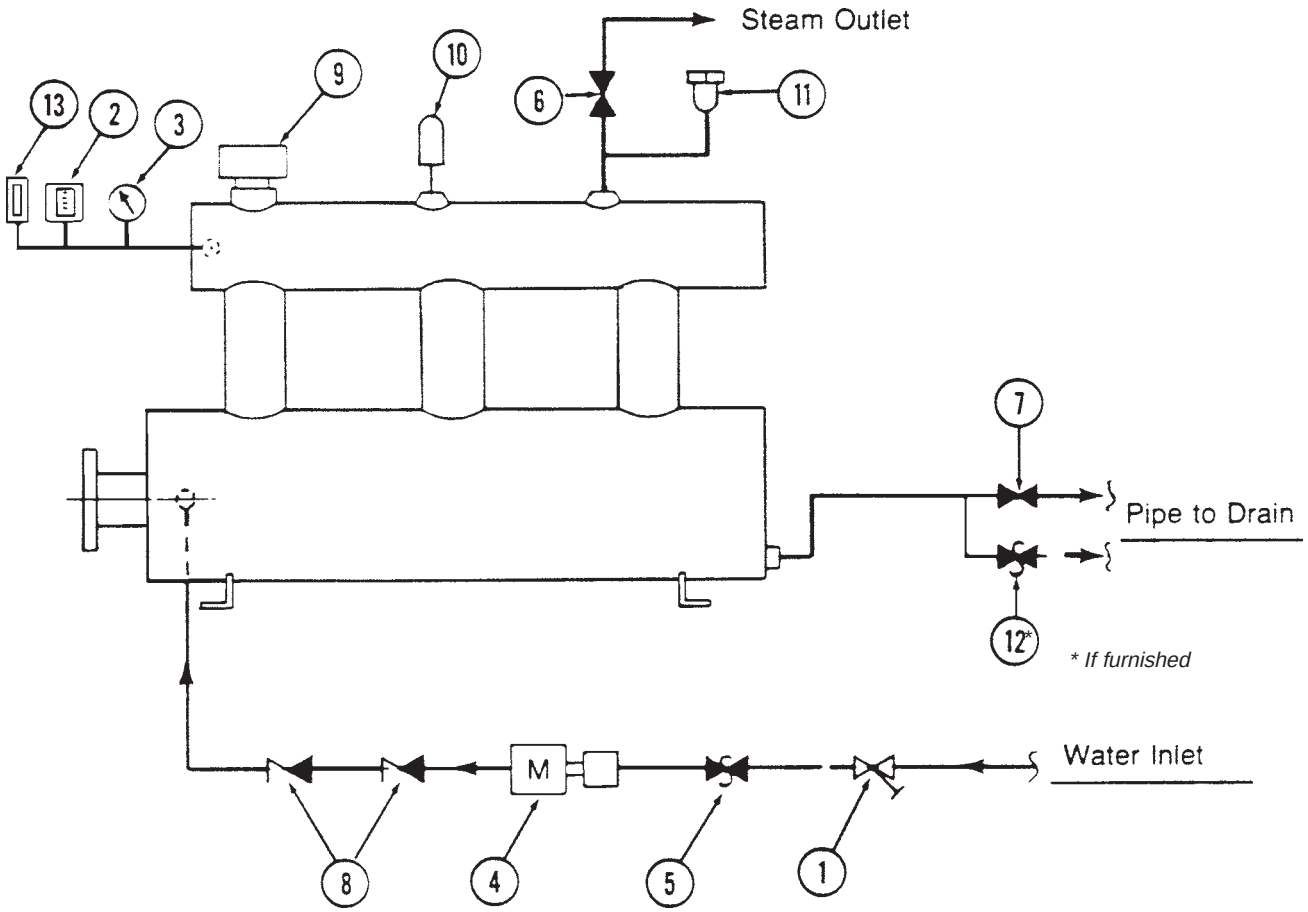
a. Turning off the sterilizer control automatically turns off the steam generators. No additional operator input is necessary. Refer to the sterilizer equipment manual for further information.



NOTE: Item 12 furnished only when automatic flush and drain is specified.

LEGEND			
1	Water Inlet Strainer	8	Check Valves
2	Operating Pressure Control	9	Water Level Control
3	Pressure Gauge	10	Safety Valve
4	Pump & Motor	11	Vacuum Valve
5	Water Inlet Solenoid	12	Flush and Drain Solenoid
6	Steam Valve	13	High-Limit Pressure Control
7	Manual Drain Valve		

Figure 2-7. Steam Generator Schematic Piping Diagram with Float Type Water-level Controls and Automatic Flushing (for units with four-digit serial numbers).



LEGEND			
1	Water Inlet Strainer	8	Check Valves
2	Operating Pressure Control	9	Water Level Control
3	Pressure Gauge	10	Safety Valve
4	Pump & Motor	11	Vacuum Valve
5	Water Inlet Solenoid	12	Flush and Drain Solenoid
6	Steam Valve	13	High-Limit Pressure Control
7	Manual Drain Valve		

NOTE: Item 12 furnished only when Automatic Flush and Drain is specified.

Figure 2-8. Steam Generator Schematic Piping Diagram with Electric Water-level Controls and Automatic Flushing (for units with five-digit serial numbers).

Section 3: Principles of Operation

3.1 OPERATIONAL DESCRIPTION – LB SERIES AND LBAS SERIES NON-SOLID STATE

The Electro-Steam generator consists of two main automatic controls: one for regulating the steam pressure and the other for maintaining the required water level.

The pressure-differential switch automatically regulates the steam pressure by turning the heating elements on and off by operating a magnetic contactor. (Refer to Figures 3-1, 3-2, or 3-3, Schematic Pipe Diagram, and to the applicable Schematic Wiring diagram in Section 3 for details.) When the steam pressure drops below the preset level, the pressure-differential switch energizes the magnetic contactor coil and applies power to the heating elements. When the pressure increases above another preset level, the switch de-energizes the magnetic contactor coil and power is disconnected from the elements. The pressure in the steam chamber is maintained between the two settings of the pressure-differential switch when the generator is in operation.

The water-level control opens the water-feed solenoid valve and turns on the pump to admit water to the boiler. When the water is restored to a preset level, the control closes the water-feed solenoid valve and turns off the pump. In addition, the water-level control overrides the pressure-differential switch by opening the circuit to the magnetic contactor when the water is below the proper level. This ensures that the heating elements will not be energized when the water level is low.

The check valves in the water-feed line allow water to flow into the boiler but prevent it from flowing back into the water line.

A safety valve is provided to release excessive boiler pressure in the event that the pressure-differential switch malfunctions; and does not turn off the heating element. The safety valve releases the boiler pressure before the boiler rating is exceeded.

Units which incorporate the automatic flushing provision (LB Series, only) use a solenoid-operated drain valve, vacuum relief valve, and timer, as well as the features described above. When the steam generator is turned on, the timer in the electric panel opens the solenoid drain valve to drain water from the boiler. When the water level in the boiler drops below the preset level, water begins to flow into the boiler. The timer holds the solenoid drain valve open for three minutes to allow the incoming water to wash out sediment and foreign deposits. After three minutes, the timer closes the drain valve and the boiler fills to the proper working level and begins to heat. The vacuum relief valve allows air to enter the steam chamber as the water in the boiler empties into the drain.

3.2 OPERATIONAL DESCRIPTION – LBAS SERIES SOLID STATE

This generator uses a solid state control in conjunction with four probes to control the water level within the unit. Two identical pressure switches control pressure. These switches are electrically connected in series: one switch operates the boiler set pressure and the other is set at a higher pressure for use as an overpressure cutout switch. The differential for each individual switch is not adjustable; only the set point is adjustable.

The solid state control has seven inputs and two outputs:

1. Inputs:
   - Two inputs, terminals A and B, are supplied 115 VAC neutral and hot, respectively.
   - Input 1 is a chassis ground.
   - Input 2 is a "pump off" signal from the control rod.
   - Input 3 is a "pump on" signal from the control rod.
   - Inputs 4 and 5 are shutoffs for the control's heater output in event of low water in boiler.
2. Outputs:
   - Output C energizes the pump and water inlet valve.
   - Output D energizes heaters.

The control is designed to maintain water level between the "pump on" and "pump off" control rods. The heater output D will be on whenever the low water / fail safe probes sense water.

The control determines resistance to ground through each of the water level probes. The resistance to ground will be less when under water. If water with high resistivity (over 100,000 ohms) is used in the generator, it can cause the control to malfunction. Water with a hardness of 0-7 grains must be provided.

3.3 OPERATIONAL DESCRIPTION – CES AND CHS SERIES / CARBON STEEL UNITS

NOTE: Refer to the appropriate wiring diagram. Please note that this diagram is for general reference only and that the specific wiring diagram for a particular boiler is located on the inside of the boiler control cabinet.

Each boiler requires both a low voltage power feed for control operation (typically 120 VAC) and a high voltage power feed for heater operation (various voltages). Each boiler has a solid state water level control with a low level cut out (LLCO) probe, a fill (FILL) probe, and a high level cut out (HLCO) probe. Each boiler also has an auxiliary low water cut out control with an auxiliary low water cut out (LWCO) probe.

The probes sense water level by measuring a small current flowing through the water between the probe and the boiler chamber. The water must have a resistivity of no more than 4700 ohms for the LLCO probe to function properly. A small voltage is applied across the shell of the boiler and the probes. When water is between the probe and the shell, the control interprets the small current between the probe and the shell as water being present. If no water is between the probe and the shell, no current will be sensed, indicating no water is present.

Starting with an empty boiler, with the boiler power switch ON, power is supplied to the solid state water level control (1CU) and the auxiliary low water cut out control (2CU). The LED on the solid state water level control associated with high water level will be ON (1CU-HLCO energized). The FILL probe senses no water and solid state water level control 1CU-FILL contacts close, energizing 1CR relay, powering the water feed solenoid and water pump. An LED on the solid state control associated with this circuit will light.

As water fills the boiler, the LLCO probe and LWCO probes sense water and provide power to the heater contactors through the hi limit (HL) and operating pressure (OP) switches. The boiler starts to heat up. The water level continues to rise and the FILL probe senses the water. The control keeps the FILL circuit energized for an additional five seconds after which 1CR1 and 1CR2 drop out, turning off the water pump and fill solenoid.

As steam is produced and used, the water level in the boiler drops. When the water drops below the FILL probe, 1CR1 and 1CR2 close and the boiler re-fills with water. Again, the fill continues for five seconds after the FILL probe senses water.

The boiler continues heating until the operating pressure switches reach set point, at which point the contactors drop out. When the pressure in the boiler drops to the differential setting on the pressure switch, the switch re-activates the contactors. Should pressure exceed the setting on the hi limit (HL) pressure switch, the hi limit (HP) switch opens and removes the control voltage to the contactors. Since the hi limit (HL) switch is a manual reset control, control voltage will not be restored to the contactors until the pressure is reduced and the manual reset button on the hi limit (HL) pressure switch is pressed.

Should the water level rise in the boiler to the HLCO probe and remain for at least two seconds, the 1CU-HLCO circuit will be de-energized, which removes power from the steam outlet solenoid valve, 1CR fill relay, and heater contactors. A visual alarm is activated and 2CR relay for remote alarm is activated. A manual reset button, located on the outside of the boiler control cabinet, must be pressed to reset the control to normal operation after the water level is lowered.

Should the water level drop below the LLCO probes for at least three seconds, the solid state water level control removes control voltage from the heater contactors by opening 1CU-LLCO contacts.

Should the water level drop below the auxiliary low water cut out probe (LWCO), the auxiliary low water cut out control removes power from the same circuit (redundant safety control).

Standard units automatically reset when water level rises above LWCO probe. However, some units have a manual reset for the auxiliary LWCO as required by some local codes. On units so equipped, the manual reset pushbutton, located on the outside of the control cabinet, must be pushed to reset the heater circuit after the water level has reached the LWCO probe.

Power Outage –

Both the solid state water level control and the auxiliary low water cut out control ignore a power loss and return to normal operation when power is restored.

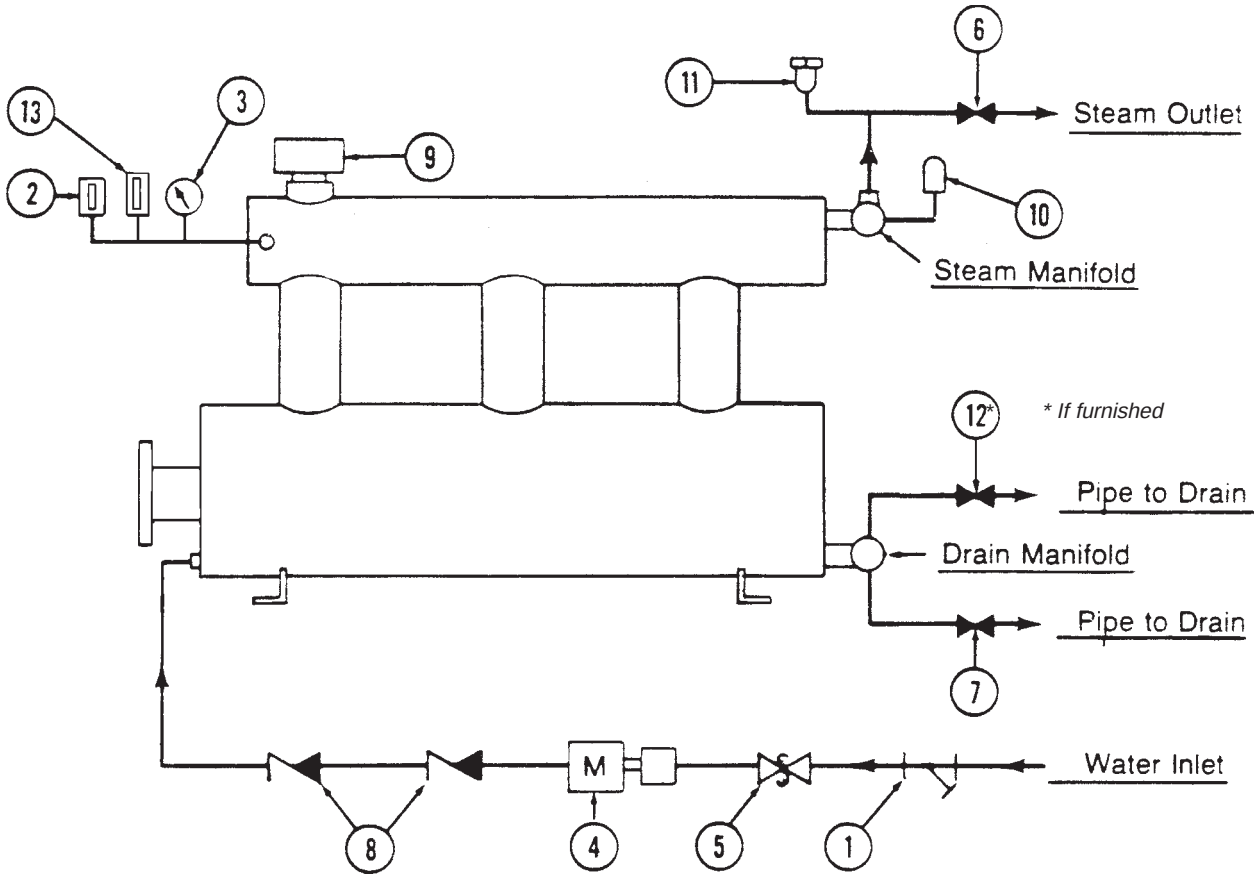
Broken wire detection –

HLCO circuit: should either wire to the HLCO probe become disconnected and two seconds pass, the HLCO circuit will be de-energized, which removes power from the steam outlet solenoid valve, 1CR fill relay, and heater contactors.

FILL circuit: should wiring to the FILL probe become disconnected, the boiler continues to fill until the HLCO circuit senses an overfill condition.

LLCO circuit: should wiring to the LLCO probe become disconnected, the water level control de-energizes the heater contactors.

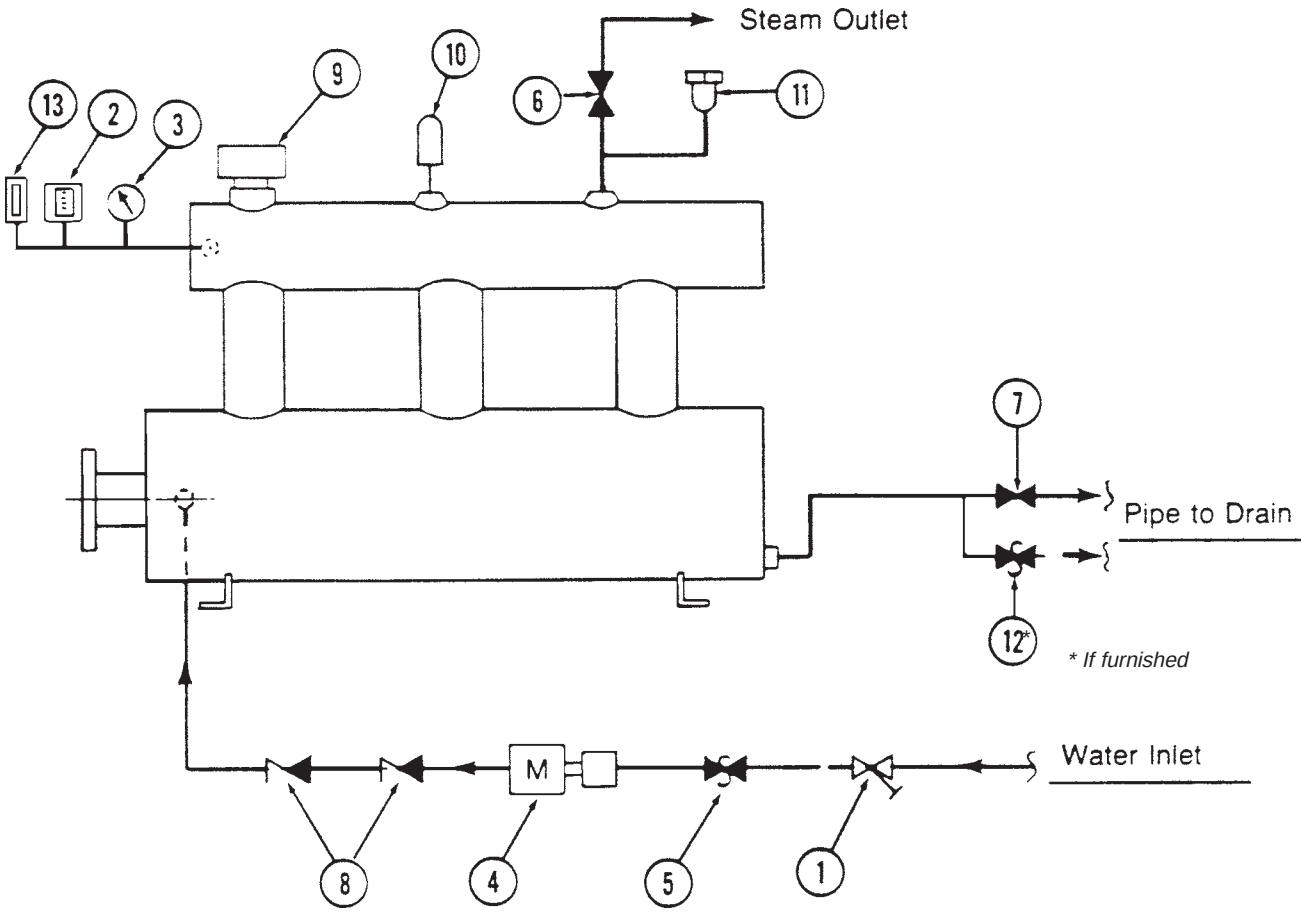
LWCO circuit: should wiring to the LWCO probe become disconnected, the auxiliary water level control de-energizes the heater contactors.



LEGEND			
1	Water Inlet Strainer	8	Check Valves
2	Operating Pressure Control	9	Water Level Control
3	Pressure Gauge	10	Safety Valve
4	Pump & Motor	11	Vacuum Valve
5	Water Inlet Solenoid	12	Flush and Drain Solenoid
6	Steam Valve	13	High-Limit Pressure Control
7	Manual Drain Valve		

** NOTE: Item 12 furnished only when Automatic Flush and Drain is specified.*

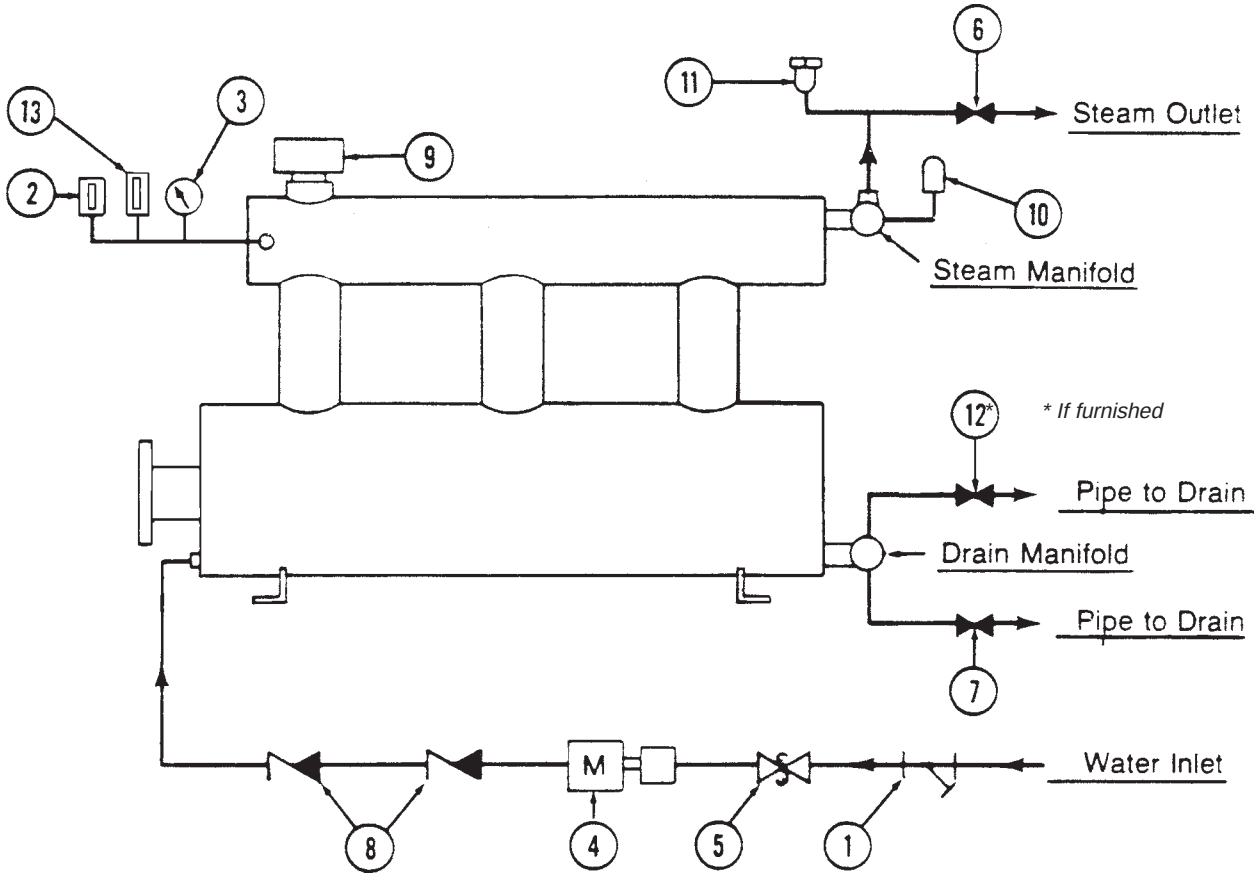
Figure 3-1. LB Steam Generator Schematic Piping Diagram with Electric Water-level Controls (for units with five-digit serial numbers).



LEGEND			
1	Water Inlet Strainer	8	Check Valves
2	Operating Pressure Control	9	Water Level Control
3	Pressure Gauge	10	Safety Valve
4	Pump & Motor	11	Vacuum Valve
5	Water Inlet Solenoid	12	Flush and Drain Solenoid
6	Steam Valve	13	High-Limit Pressure Control
7	Manual Drain Valve		

** NOTE: Item 12 furnished only when Automatic Flush and Drain is specified.*

Figure 3-2. LB Steam Generator Schematic Piping Diagram with Electric Water-level Controls (for units with five-digit serial numbers).



LEGEND			
1	Water Inlet Strainer	8	Check Valves
2	Operating Pressure Control	9	Water Level Control
3	Pressure Gauge	10	Safety Valve
4	Pump & Motor	11	Vacuum Valve
5	Water Inlet Solenoid	12	Flush and Drain Solenoid
6	Steam Valve	13	High-Limit Pressure Control
7	Manual Drain Valve		

** NOTE: Item 12 furnished only when Automatic Flush and Drain is specified.*

Figure 3-3. LB Steam Generator Schematic Piping Diagram with Electric Water-level Controls (for units with five-digit serial numbers).

3.4 OPERATIONAL DESCRIPTION - CES / STAINLESS-STEEL UNITS

NOTE: Refer to the appropriate wiring diagram. Please note that this diagram is for general reference only and that the specific wiring diagram for a particular boiler is located on the inside of the boiler control cabinet.

Each boiler requires both a low voltage power feed for control operation (typically 120 VAC) and a high voltage power feed for heater operation (various voltages). Each boiler has a solid state water level control with a low level cut out (LLCO) switch, a pump on (HP) switch, a pump off (LP) switch, and a high level cut out (HLCO) switch. Each boiler also has an auxiliary low water cut out control with an auxiliary low water cut out (LWCO) switch.

The water level is measured by floats in the boiler chamber, which ride on the water surface and activate the switches contained in the float support.

Starting with an empty boiler, with the boiler power switch ON, power is supplied to the solid state water level control (1CU) and the auxiliary low water cut out control (2CU). The LED on the solid state water level control associated with high water level will be ON (1CU-HLCO energized). The float for the FILL circuit is below the pump on (HP) switch point, indicating insufficient water in the boiler, and solid state water level control 1CU-FILL contacts are closed, energizing 1CR relay, powering the water feed solenoid and water pump. An LED on the solid state control associated with this circuit will light.

As water fills the boiler, the floats rise above the low level cut out (LLCO) switch point and auxiliary low water cut out (LWCO) switch point indicating sufficient water and the controls provide power to the heater contactors through the hi limit (HL) and operating pressure (OP) switches. The boiler starts to heat up. The water level and the float continue to rise and the float trips the pump off (LP) switch. The control then keeps the fill circuit energized for an additional five seconds after which 1CR1 and 1CR2 drop out, turning off the water pump and fill solenoid.

As steam is produced and used, the water level in the boiler drops. When the water falls and the float drops below the pump on (HP) switch, 1CR1 and 1CR2 close and the boiler re-fills with water. Again, the fill continues for five seconds after the pump off (LP) switch is tripped.

The boiler continues heating until the pressure reaches the operating control's upper set point, at which point the contactors drop out. When the pressure in the boiler drops below the lower setting on the operating pressure control, the switch re-activates the contactors. Should pressure exceed the setting on the hi limit (HL) pressure switch, the hi limit (HL) switch opens and removes the control voltage to the contactors. Since the hi limit (HL) switch is a manual reset control, control voltage will not be restored to the contactors until the pressure is reduced and the manual reset button on the hi limit (HL) pressure switch is pressed.

Should the water level rise in the boiler and the float trips the high level cut out switch (HLCO) and remains for at least two seconds, the 1CU-HLCO circuit de-energizes, which removes power from the steam outlet solenoid valve, 1CR fill relay, and heater contactors. A visual alarm is activated and 2CR relay for remote alarm is activated. A manual reset button, located on the outside the boiler control cabinet, must be pressed to reset the control to normal operation after the water level is lowered.

Should the water level drop the float below the low level cut out (LLCO) switch for at least three seconds, the solid state water level control removes control voltage from the heater contactors by opening 1CU-LLCO contacts.

Should the water level drop the float below the auxiliary low water cut out switch (LWCO), the auxiliary low water cut out control will remove power from the same circuit (redundant safety control).

Standard units automatically reset when water level rises and moves the float above auxiliary low water cut out (LWCO) switch. However, some units have a manual reset for the auxiliary low water cut out (LWCO), as required by some local codes. On units so equipped, the manual reset pushbutton, located on the outside of the control cabinet, must be pushed to reset the heater circuit after the water level has risen above the auxiliary low water cut out (LWCO) switch.

Power Outage –

Both the solid state water level control and the auxiliary low water cut out control ignore a power loss and return to normal operation when power is restored.

Broken wire detection –

HLCO circuit: should either wire to the HLCO switch become disconnected and two seconds pass, the HLCO circuit de-energizes, which removes power from the

steam outlet solenoid valve, 1CR fill relay, and heater contactors.

FILL circuit: should wiring to the pump on or pump off switch become disconnected, the boiler continues to fill until the HLCO circuit senses an overfill condition.

LLCO circuit: should the wiring to the LLCO switch become disconnected, the water level control de-energizes the heater contactors.

LWCO circuit: should the wiring to the LWCO switch become disconnected, the auxiliary water level control de-energizes the heater contactors.

3.5 WIRING - GENERAL

⚠ WARNING - ELECTRIC SHOCK HAZARD: A qualified individual must effectively ground any installation involving electric heaters in accordance with the National Electrical Code.

1. Wire only with properly sized and insulated wiring per the National Electric Code (NEC) following the wiring diagram supplied with the boiler.
2. No internal wiring is required. The boiler is completely wired and tested before shipment. Primary power circuit and a separate control circuit are used to power the boiler. Primary power, wire size, and equipment must be rated per NEC. The control circuit power should be connected to the control circuit terminal block, located inside the access door.
3. User should provide a safety switch, employing circuit breakers or fuses, between the main power source and the boiler.
4. Because of their water lines, boilers are susceptible to lightning damage. Industrial type lightning protector should be installed at the electrical service entrance. Check your contractor or electrical dealer for the recommended type of protector for your system.
5. Confirm that the supply voltages match nameplate ratings on the boiler.
6. Be sure all electrical connections, both inside the boiler and in the power supply wiring, are properly tightened and retighten, if required, before energizing the boiler.
7. Substitution of components or modification of the wiring voids the warranty and may lead to dangerous operating conditions.

3.6 WIRING DIAGRAM

3.6.1 CES and CHS Units (Carbon Steel)

Wiring for specific boiler is located on the inside of the control cabinet of the boiler.

3.6.2 CES Units (Stainless Steel)

Wiring for specific boiler is located on the inside of the control cabinet of the boiler.

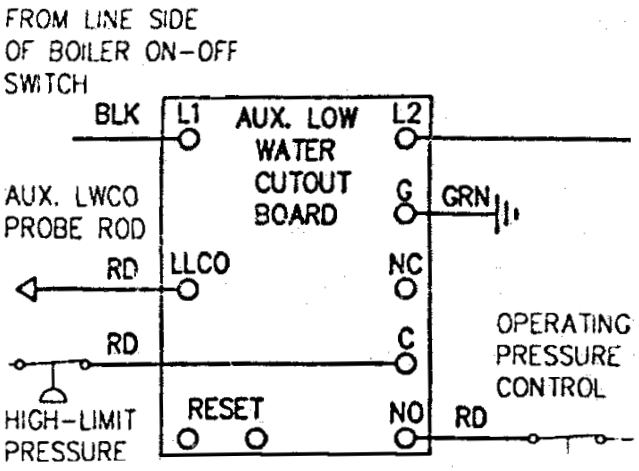


Figure 3-4.
Typical Auxilliary Low Water Cut Out

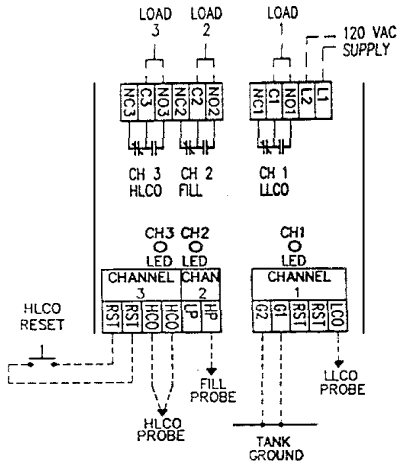
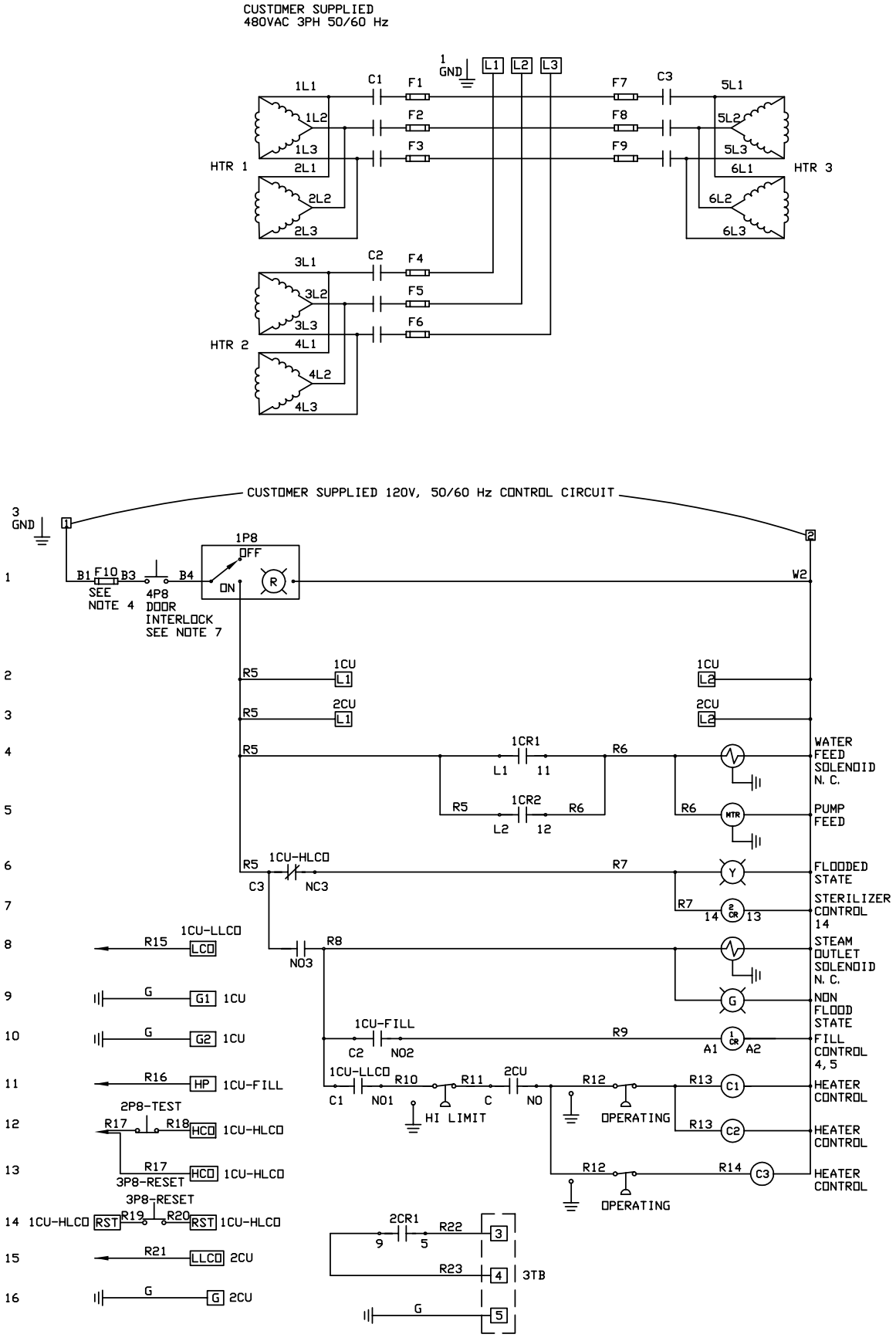


Figure 3-5.
Solid State Liquid Level Control

Figure 3-6.
Typical Wiring Diagram: CES and CHS Carbon Steel



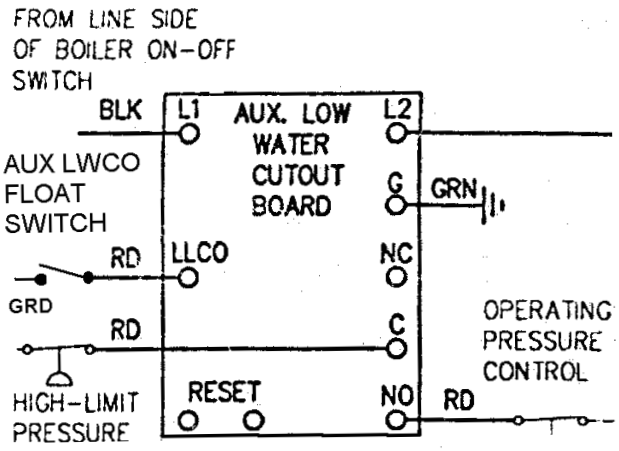


Figure 3-7.
Typical Auxilliary Low Water Cut Out
(Units w/ Floats)

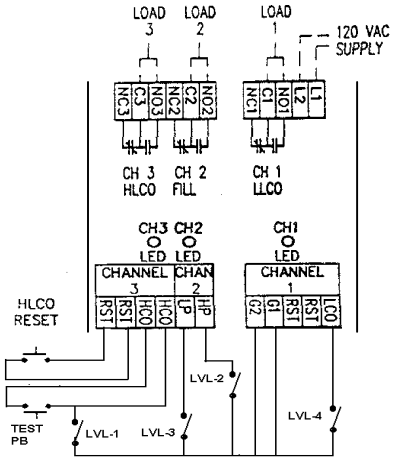
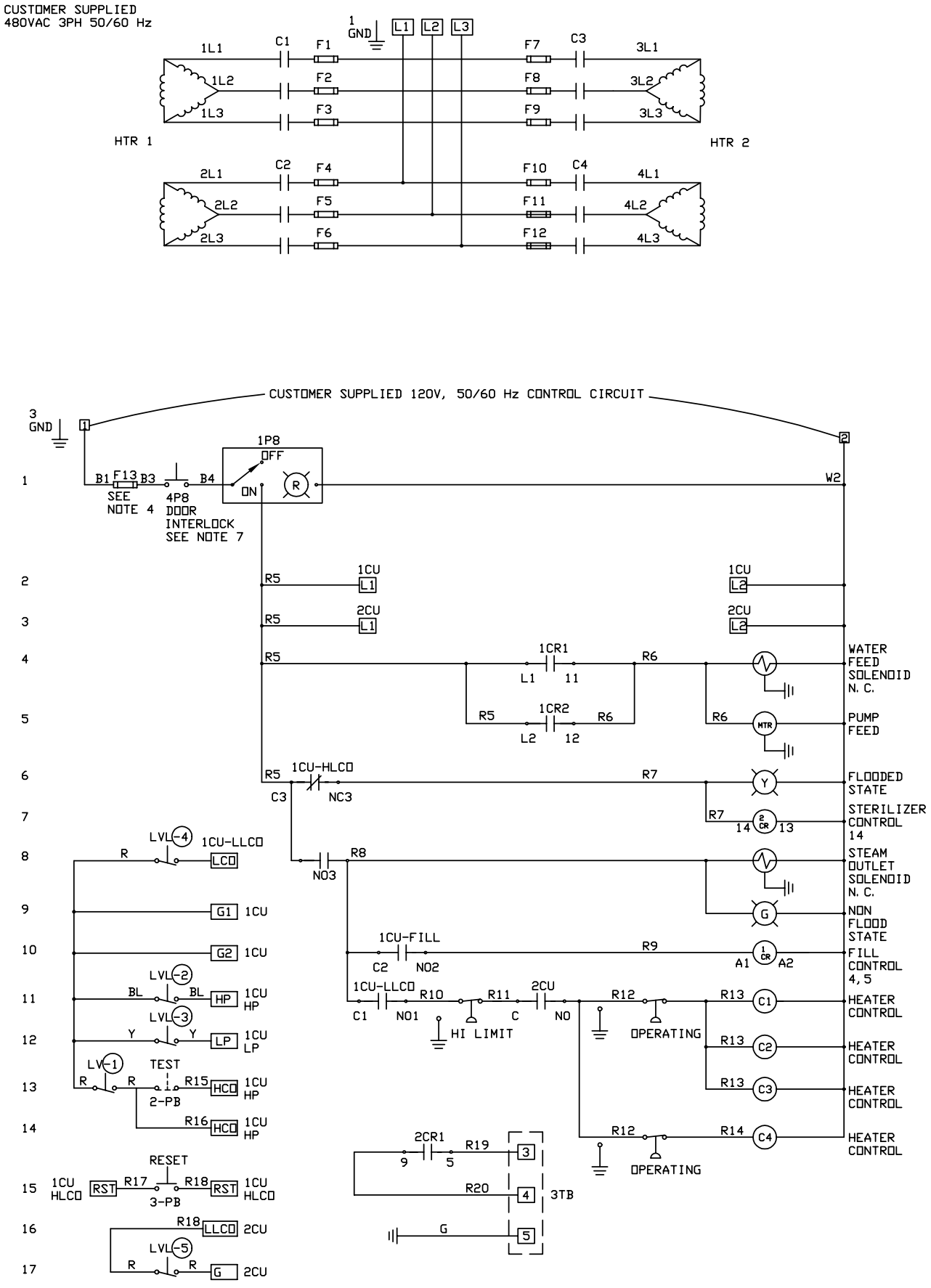
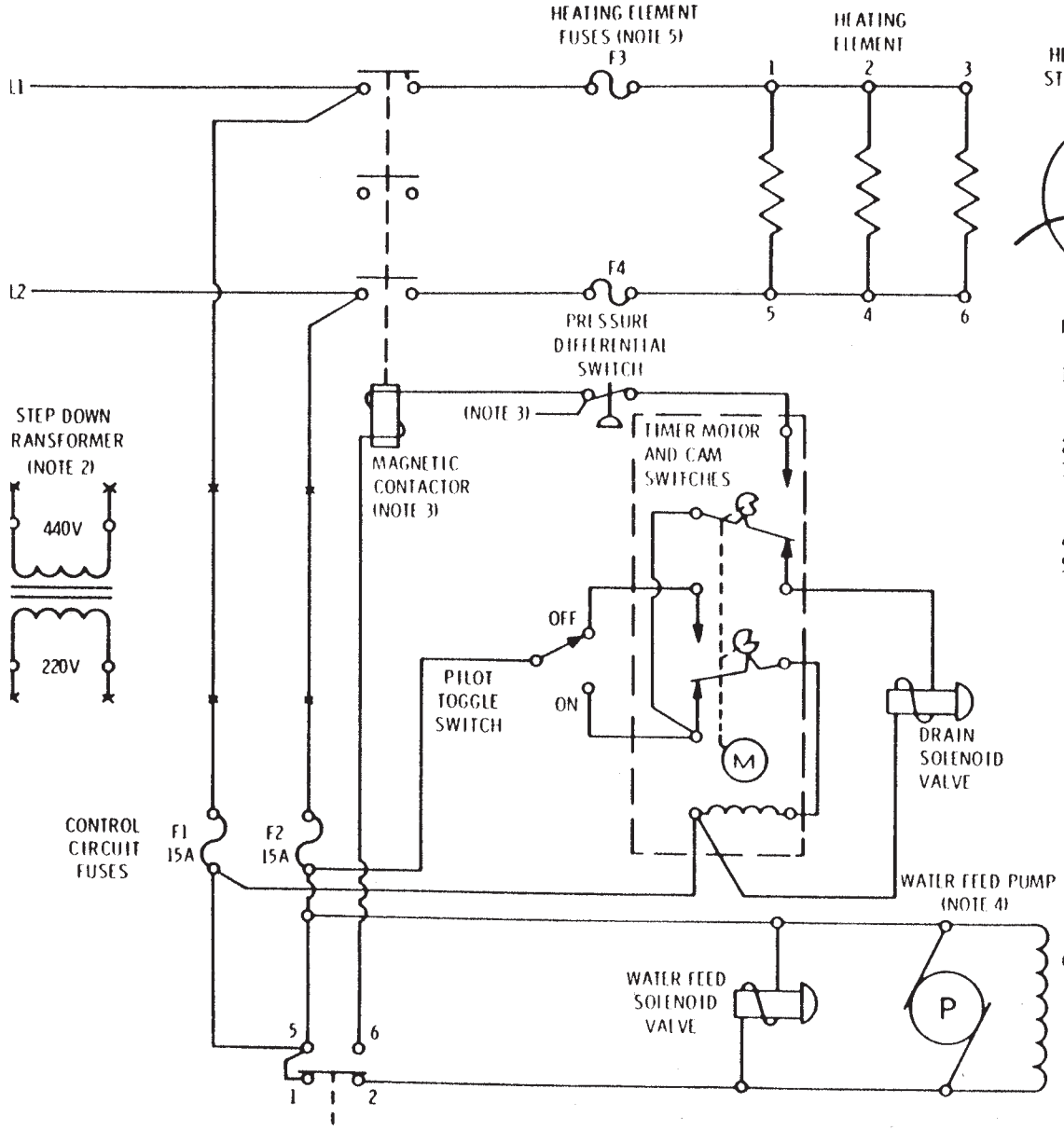
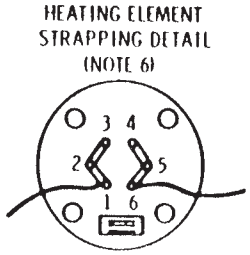


Figure 3-8.
Solid State Liquid Level Control
(Units w/ Floats)

Figure 3-9.
Typical Wiring Diagram: CES Stainless Steel







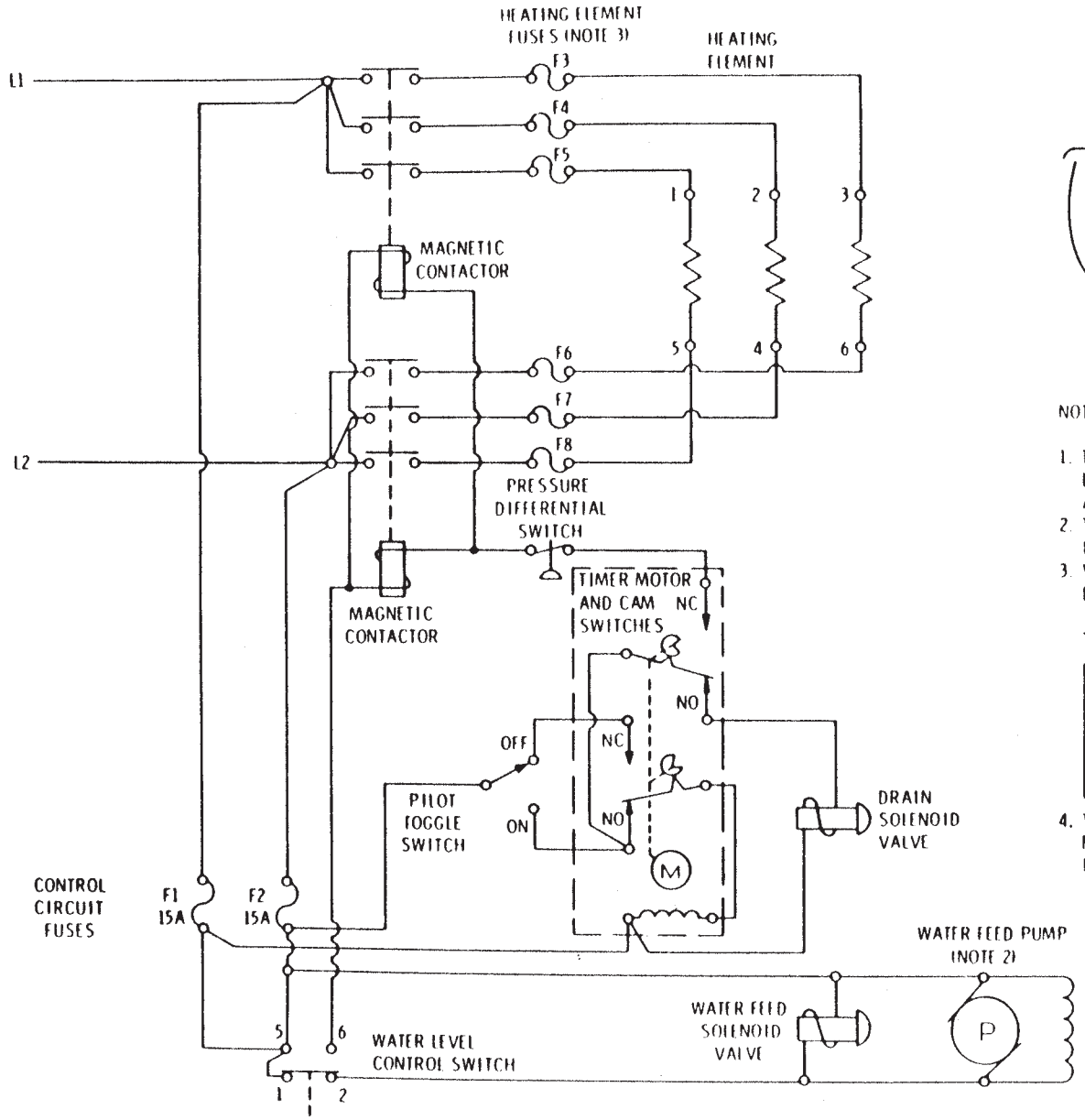
NOTES:

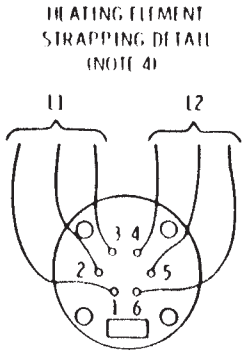
1. THIS DIAGRAM APPLIES TO ALL AUTOMATIC FLUSH MODELS WIRED FOR SINGLE-PHASE OPERATION (EXCEPT LB-15 AND LB-20 SINGLE PHASE, 230 VAC).
2. STEP-DOWN TRANSFORMER IS USED FOR 440V OPERATION ONLY.
3. MODELS WITH MULTIPLE SECTIONS USE A MAGNETIC CONTACTOR, A SET OF TWO FUSES, AND A HEATING ELEMENT FOR EACH SECTION.
4. THE LOW PRESSURE OPTION DOES NOT USE A WATER PUMP.
5. VALUES FOR THE HEATING ELEMENT FUSES DEPEND ON THE TYPE OF HEATING ELEMENT USED IN A PARTICULAR SECTION. THE HEATING ELEMENT TYPE IS STAMPED ON THE NAMEPLATE OF THE ELEMENT. FUSES FOR A SPECIFIC HEATING ELEMENT ARE LOCATED DIRECTLY ABOVE THEIR RESPECTIVE ELEMENT.

	FUSE RATING F3 & F4	HEATING ELEMENT WATTAGE	HEATING ELEMENT MODEL
220V OPERATION	50	10 KW	HE103
	40	7.5 KW	HE104
440V OPERATION	50	20 KW	HE101A
	40	15 KW	HE102A
	30	10 KW	HE103A
	30	7.5 KW	HE104A

6. TERMINALS ON HEATING ELEMENTS ARE NOT ACTUALLY NUMBERED. NUMBERS ARE ASSIGNED FOR REFERENCE PURPOSES ONLY.

Figure 3-10. LB Series Steam Generator Schematic Wiring Diagram, Single-Phase with Float-Type Water-Level Control and Automatic Flushing (for units with four-digit serial numbers).





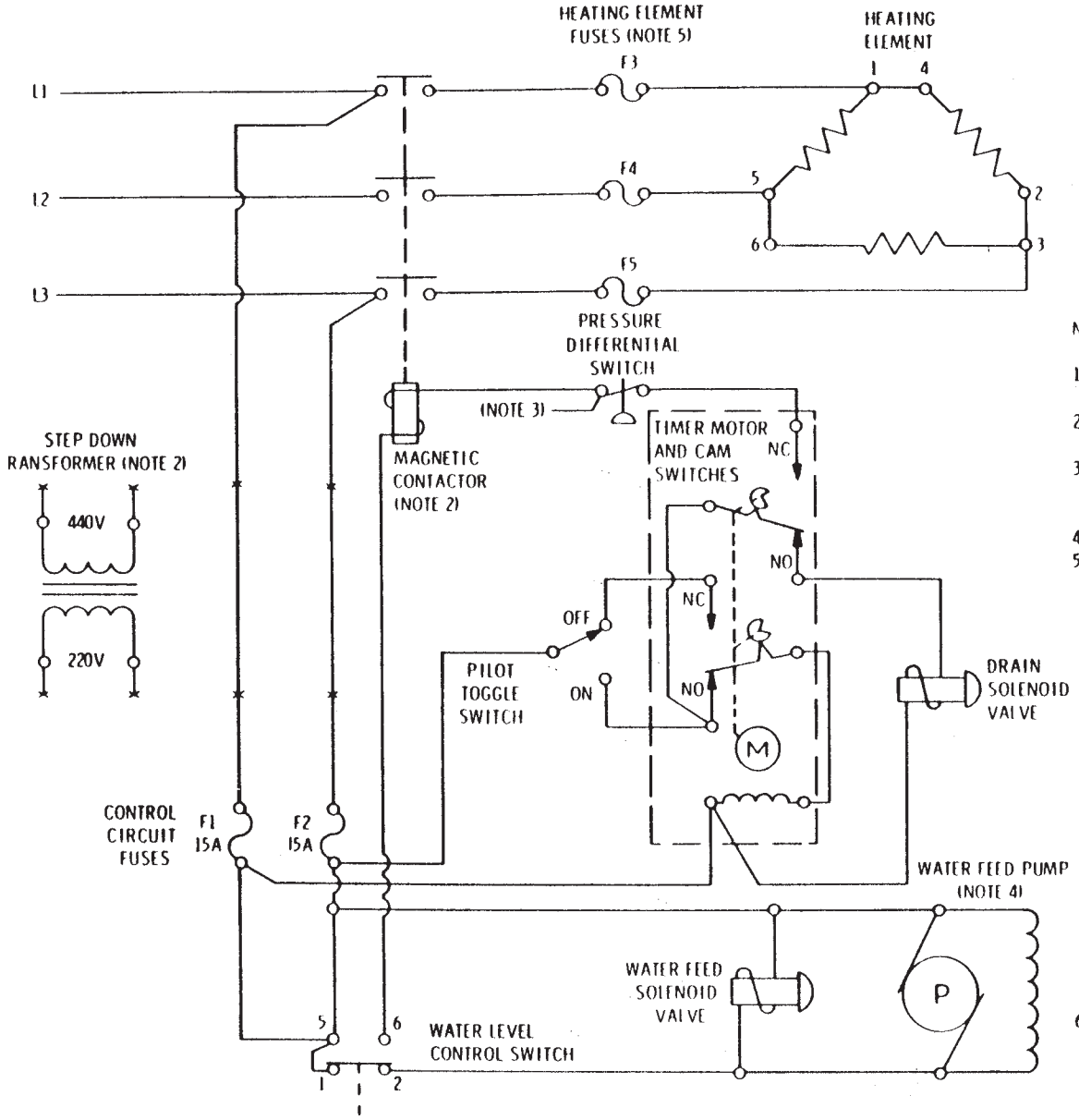
NOTES:

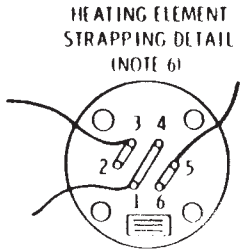
1. THIS DIAGRAM APPLIES TO AUTOMATIC FLUSH MODELS LB-15 AND LB-20 ONLY WHEN OPERATED SINGLE PHASE AT 230 VOLTS.
2. THE LOW PRESSURE OPTION DOES NOT USE A WATER PUMP.
3. VALUES FOR THE HEATING ELEMENT FUSES F3, F4 AND F5 DEPEND ON THE TYPE HEATING ELEMENT USED. THE HEATING ELEMENT TYPE IS STAMPED ON THE NAMEPLATE OF THE ELEMENT.

FUSE RATING F3 THRU F8	HEATING ELEMENT	
	WATTAGE	MODEL
40A	20 KW	HE101
30A	15 KW	HE102

4. TERMINALS ON HEATING ELEMENTS ARE NOT ACTUALLY NUMBERED. NUMBERS ARE ASSIGNED FOR REFERENCE PURPOSES ONLY.

Figure 3-11. LB-15 andLB-20 Steam Generator Schematic Wiring Diagram, Single-Phase 230-Volt with Float-Type Water-Level Control and Automatic Flushing (for units with four-digit serial numbers).





NOTES:

1. THIS DIAGRAM APPLIES TO ALL AUTOMATIC FLUSH MODELS WIRED FOR THREE PHASE OPERATION.
2. THE 440V-TO-200V STEP-DOWN TRANSFORMER IS USED FOR 440V OPERATION ONLY.
3. MODELS WITH MULTIPLE SECTIONS USE A SEPARATE MAGNETIC CONTACTOR, A SET OF THREE FUSES, AND A HEATING ELEMENT FOR EACH SECTION.
4. LOW PRESSURE OPTION DOES NOT USE A WATER PUMP.
5. VALUES FOR THE HEATING ELEMENT FUSES F3, F4 AND F5 DEPEND ON THE TYPE OF HEATING ELEMENT USED IN A SPECIFIC SECTION. THE HEATING ELEMENT TYPE IS STAMPED ON THE NAMEPLATE OF THE ELEMENT. FUSES FOR A SPECIFIC HEATING ELEMENT ARE LOCATED DIRECTLY ABOVE THEIR RESPECTIVE ELEMENT.

		HEATING ELEMENT	
	FUSE RATING	WATTAGE	MODEL
208V OR 220V OPERATION	60A	20 KW	HE101
	50	15 KW	HE102
	30	10 KW	HE103
	30	7.5 KW	HE104
440V OPERATION	30A	20 KW	HE101A
	30	15 KW	HE102A
	30	10 KW	HE103A
	30	7.5 KW	HE104A

6. TERMINALS ON HEATING ELEMENTS ARE NOT ACTUALLY NUMBERED. NUMBERS ARE ASSIGNED FOR REFERENCE PURPOSES ONLY.

Figure 3-12. LB Series Steam Generator Schematic Wiring Diagram, Three-Phase with Float-Type Water-Level Control and Automatic Flushing (for units with four-digit serial numbers).

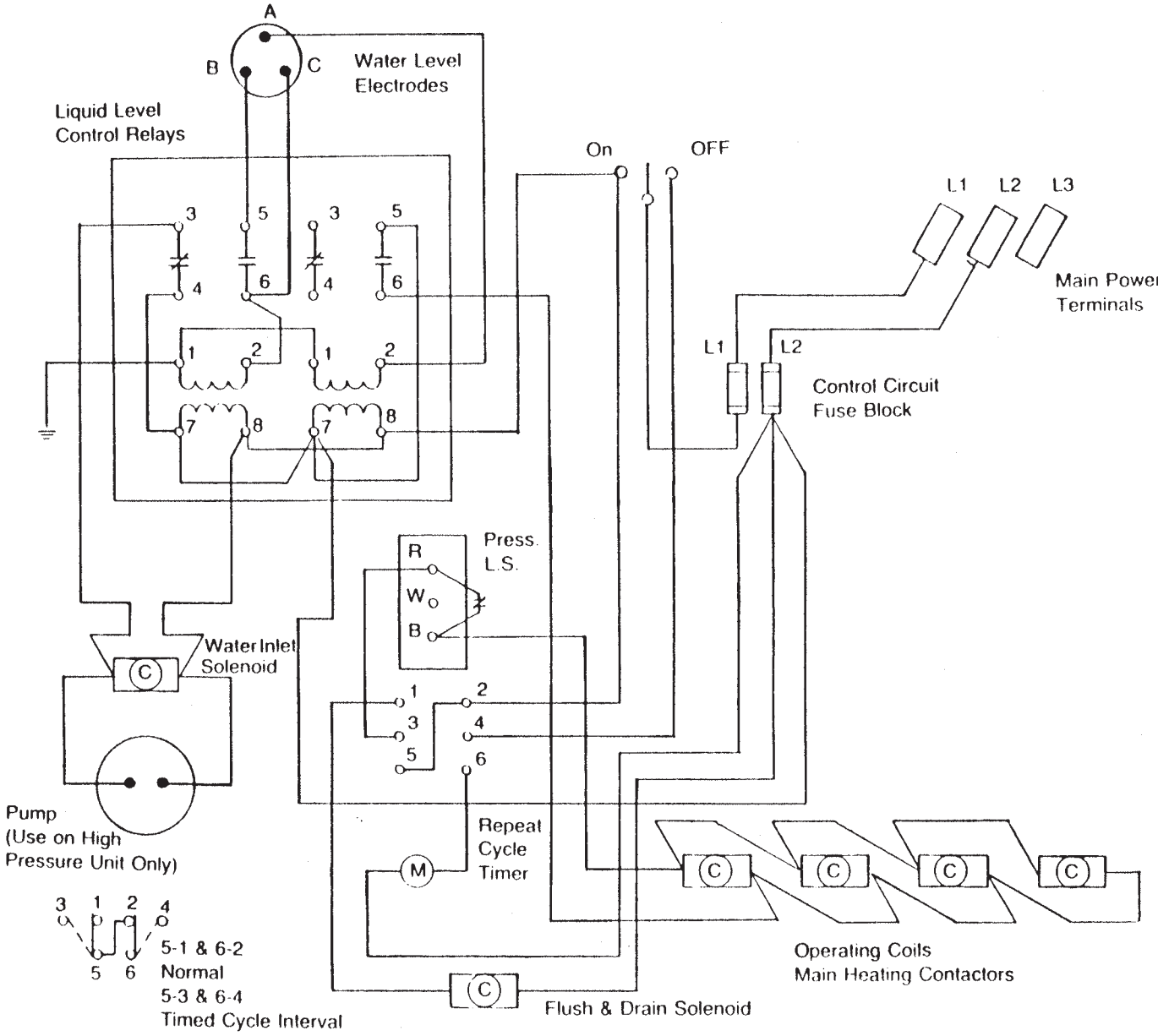


Figure 3-13. Wiring Diagram – LB Series with Electric Water-Level Control and Automatic Flush and Drain; 208-240 Volt Three-Phase, 60 Hz (for units with five-digit serial numbers).

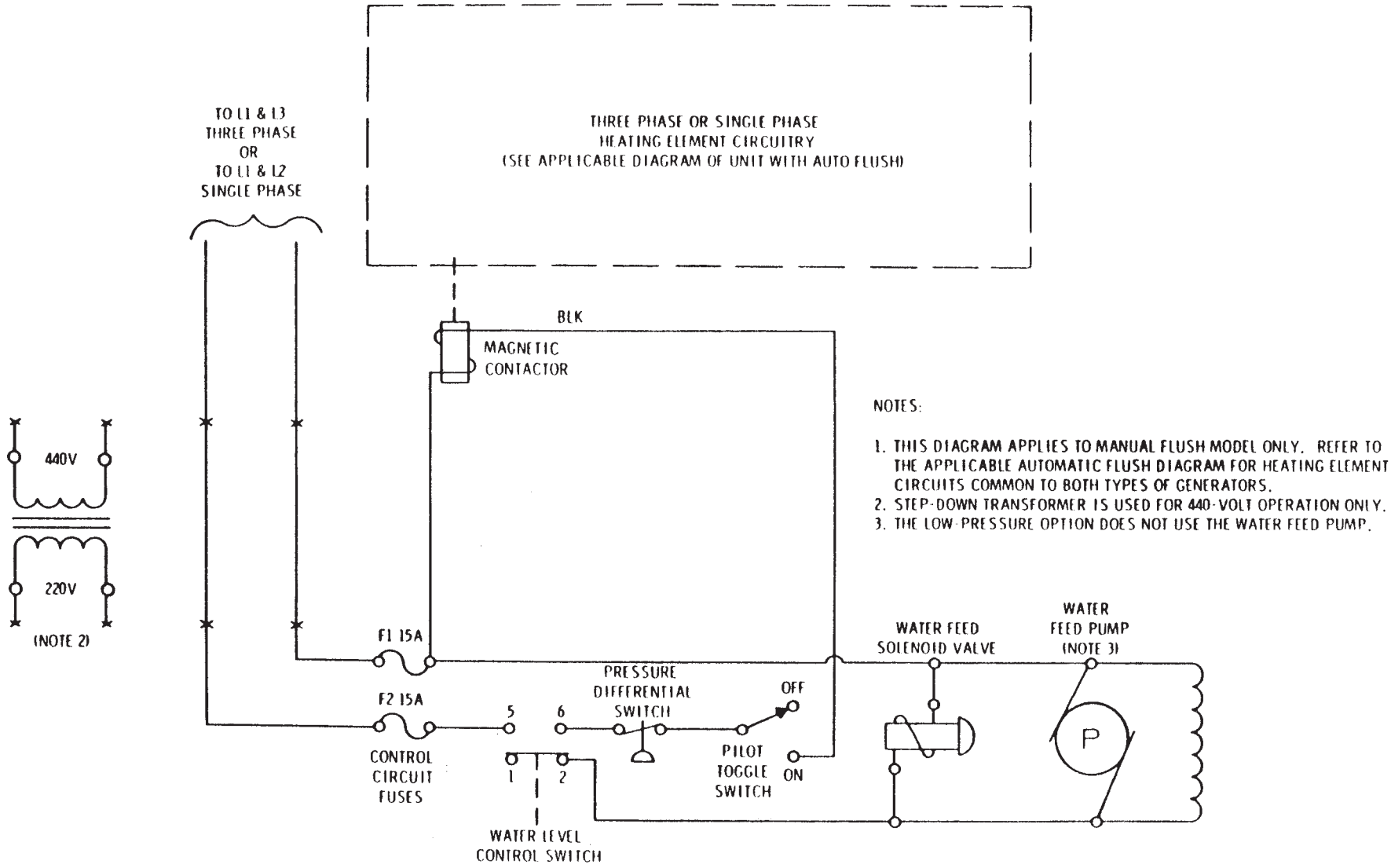


Figure 3-14. LB Series Steam Generator Schematic Wiring Diagram (for units without automatic flushing).

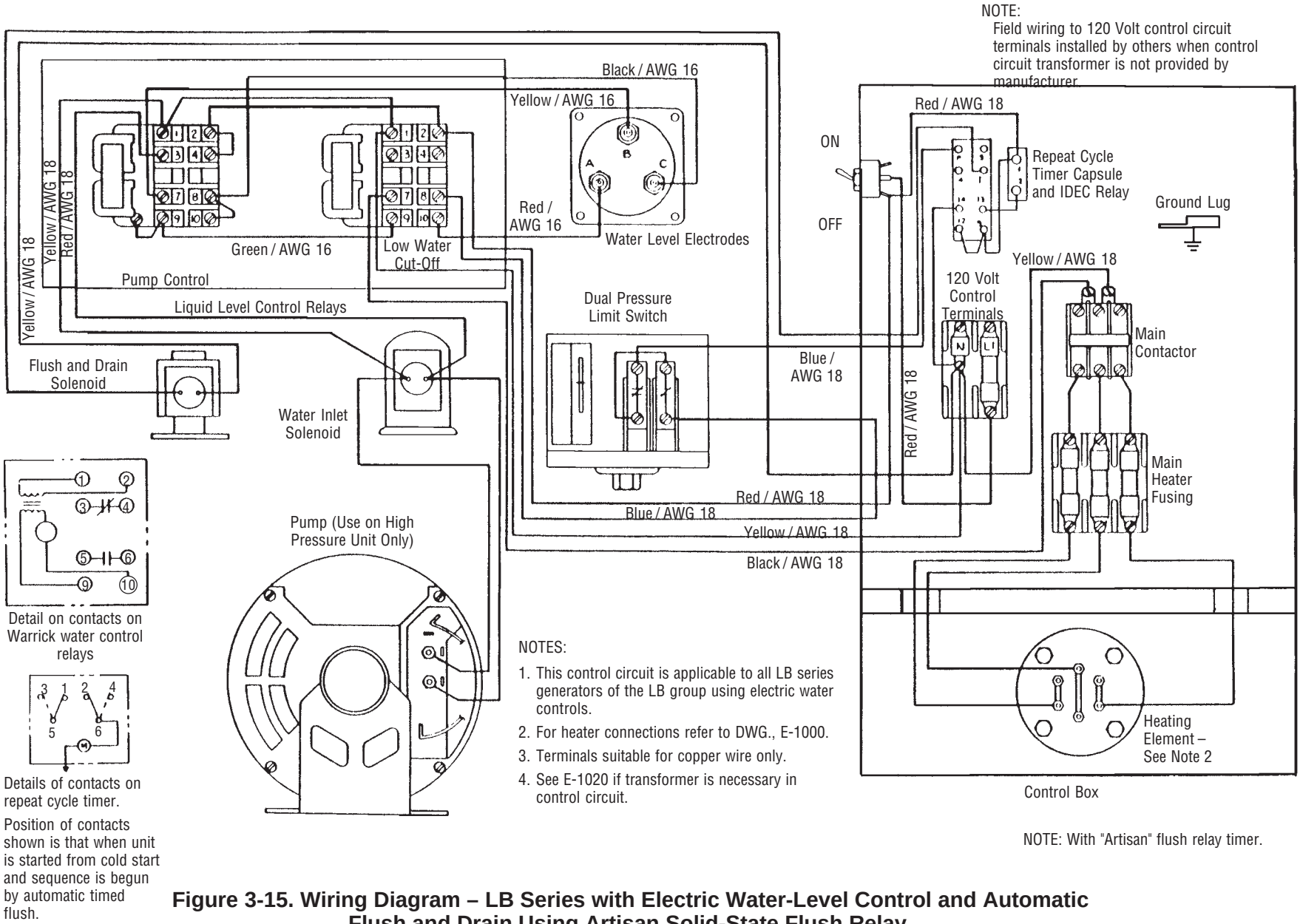

NOTE:
Field wiring to 120 Volt control circuit terminals installed by others when control circuit transformer is not provided by manufacturer.
Black / AWG 16
Yellow / AWG 16
Red / AWG 18
ON
OFF
Repeat Cycle Timer Capsule and IDEC Relay
Ground Lug
Yellow / AWG 18
120 Volt Control Terminals
Main Contactor
Yellow / AWG 18
Red / AWG 16
Water Level Electrodes
Green / AWG 16
Low Water Cut-Off
Pump Control
Liquid Level Control Relays
Dual Pressure Limit Switch
Blue / AWG 18
Red / AWG 18
Flush and Drain Solenoid
Water Inlet Solenoid
Red / AWG 18
Blue / AWG 18
Yellow / AWG 18
Black / AWG 18
Main Heater Fusing
Pump (Use on High Pressure Unit Only)
Heating Element – See Note 2
Control Box
Detail on contacts on Warrick water control relays
Details of contacts on repeat cycle timer.
Position of contacts shown is that when unit is started from cold start and sequence is begun by automatic timed flush.
NOTES:
1. This control circuit is applicable to all LB series generators of the LB group using electric water controls.
2. For heater connections refer to DWG., E-1000.
3. Terminals suitable for copper wire only.
4. See E-1020 if transformer is necessary in control circuit.
NOTE: With "Artisan" flush relay timer.

Figure 3-15. Wiring Diagram – LB Series with Electric Water-Level Control and Automatic Flush and Drain Using Artisan Solid-State Flush Relay.

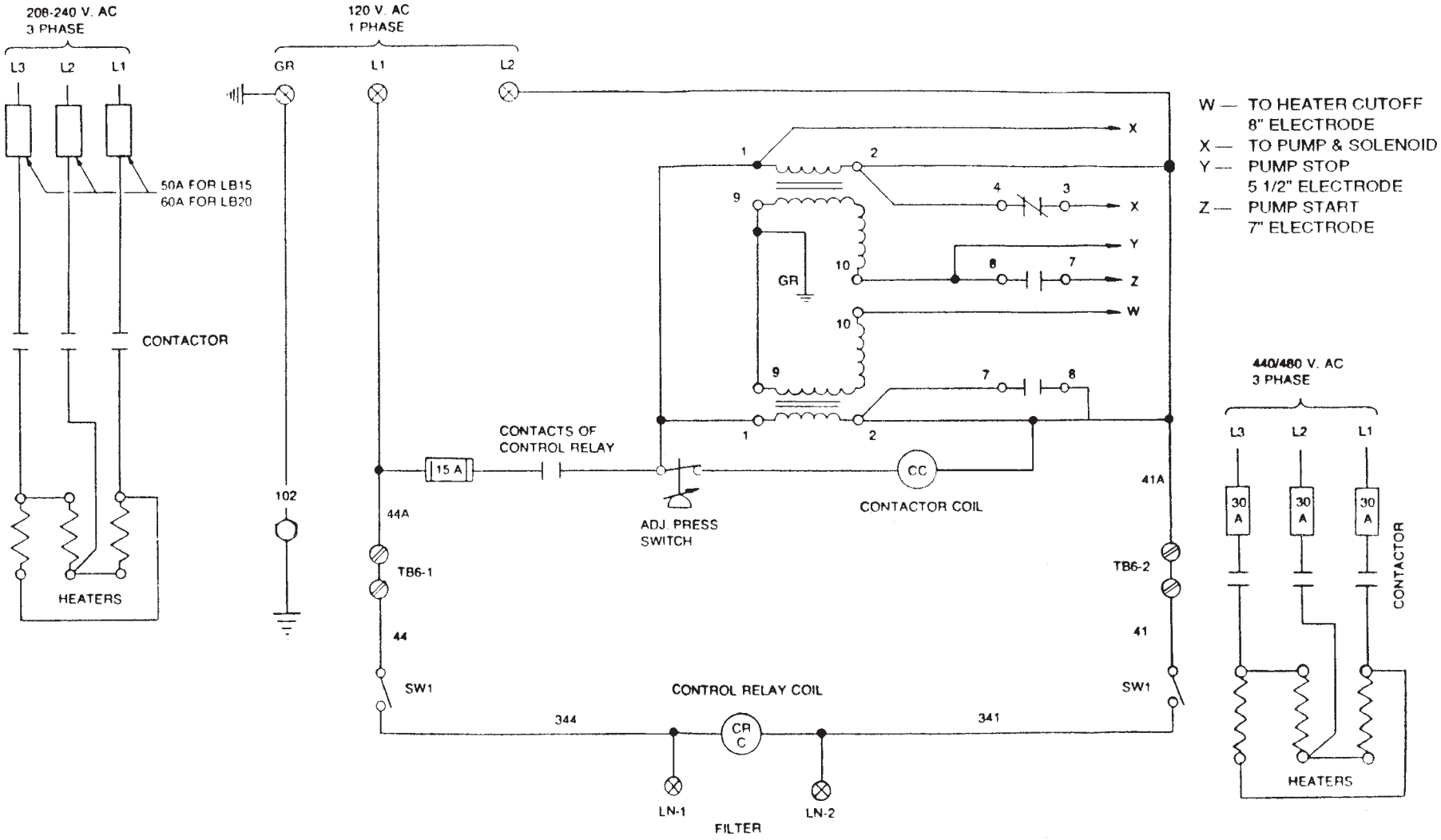


Figure 3-16. LB15AS and LB20AS Steam Generator Electrical Schematic; Three-Phase with Electric Water-Level Control (non-solid state).

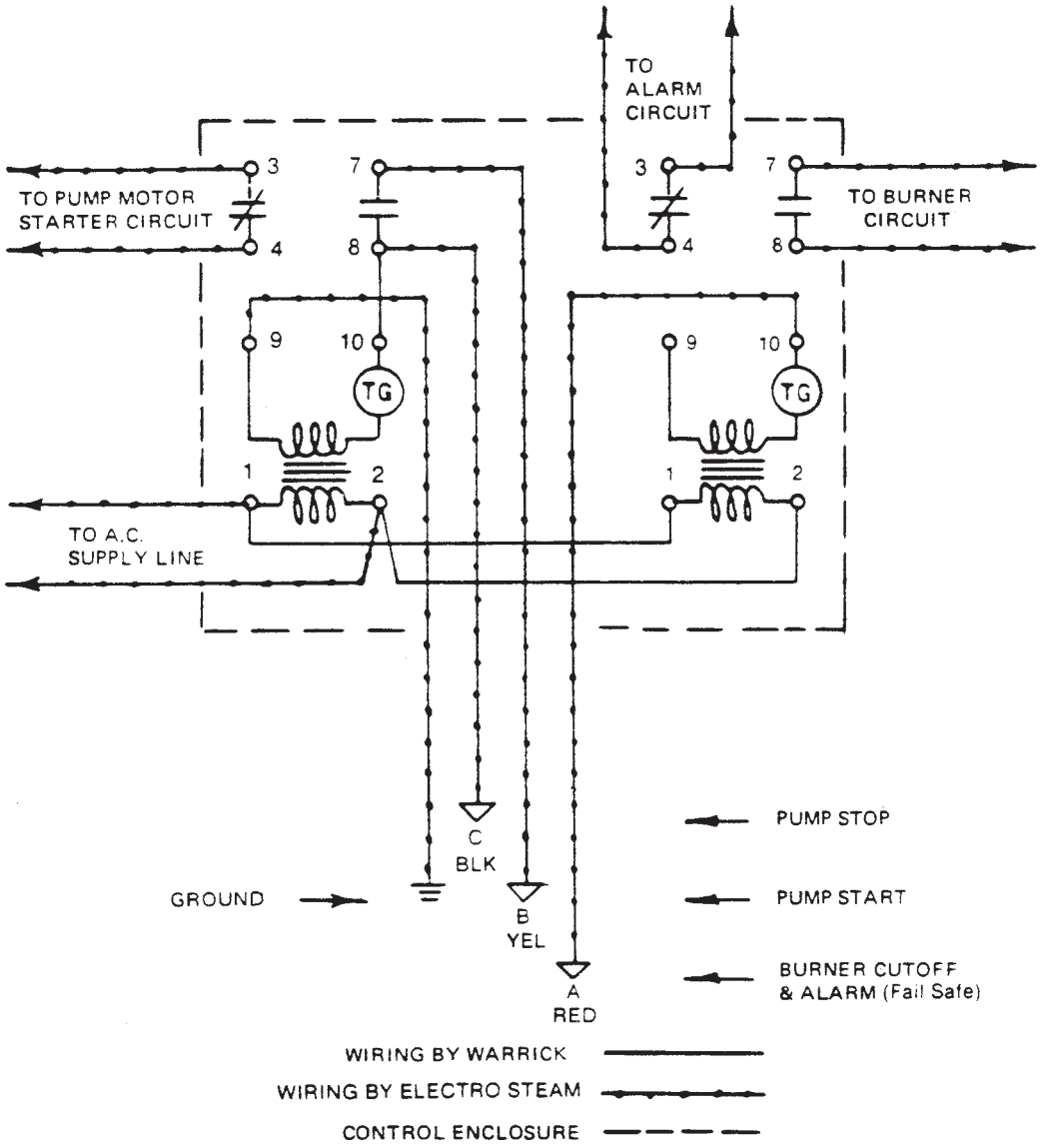


Figure 3-17. Wiring Schematic for Floatless Type Water-Level Control (Non-solid State).

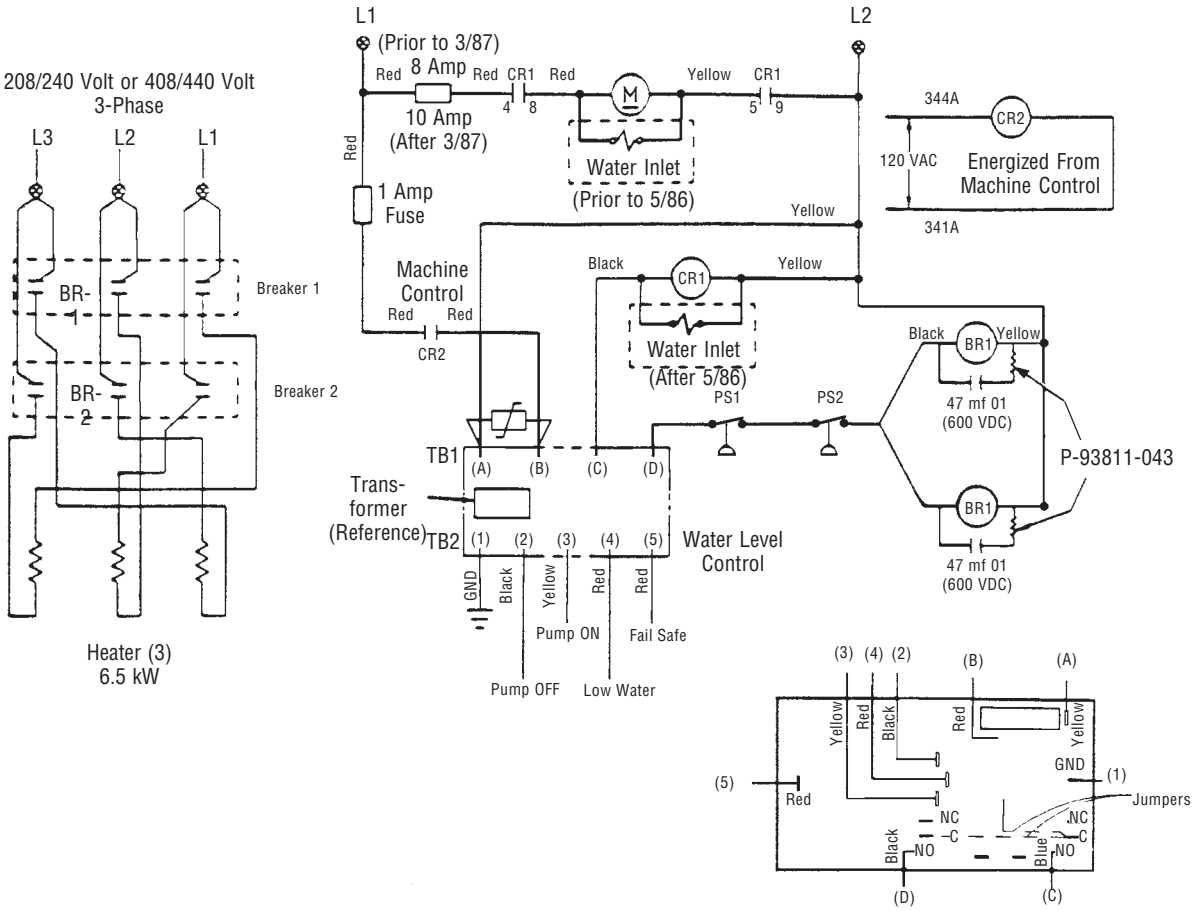


Figure 3-18. LBAS Series Solid State Control – Wiring Diagram (for units with two contactors).

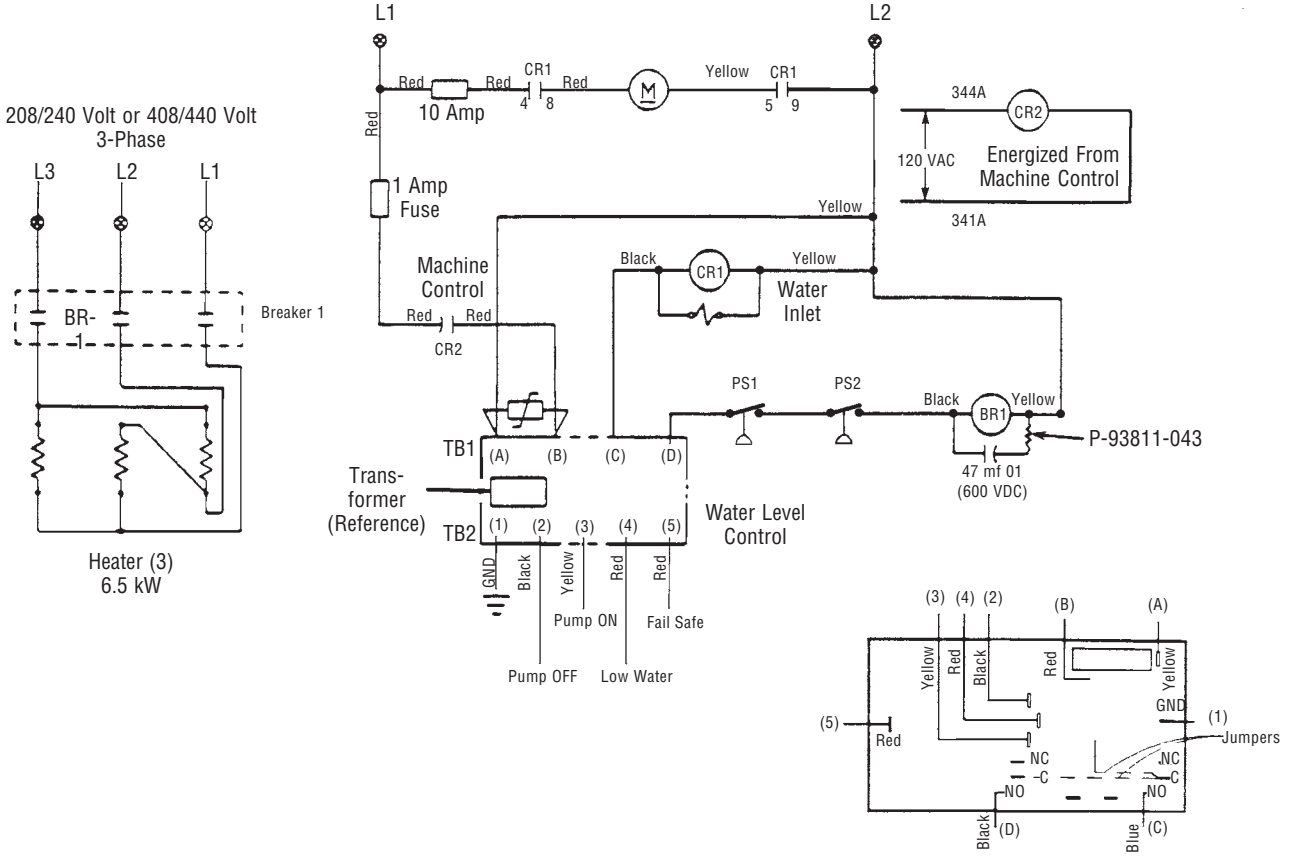


Figure 3-19. LBAS Series Solid State Control – Wiring Diagram (for units with one contactor).

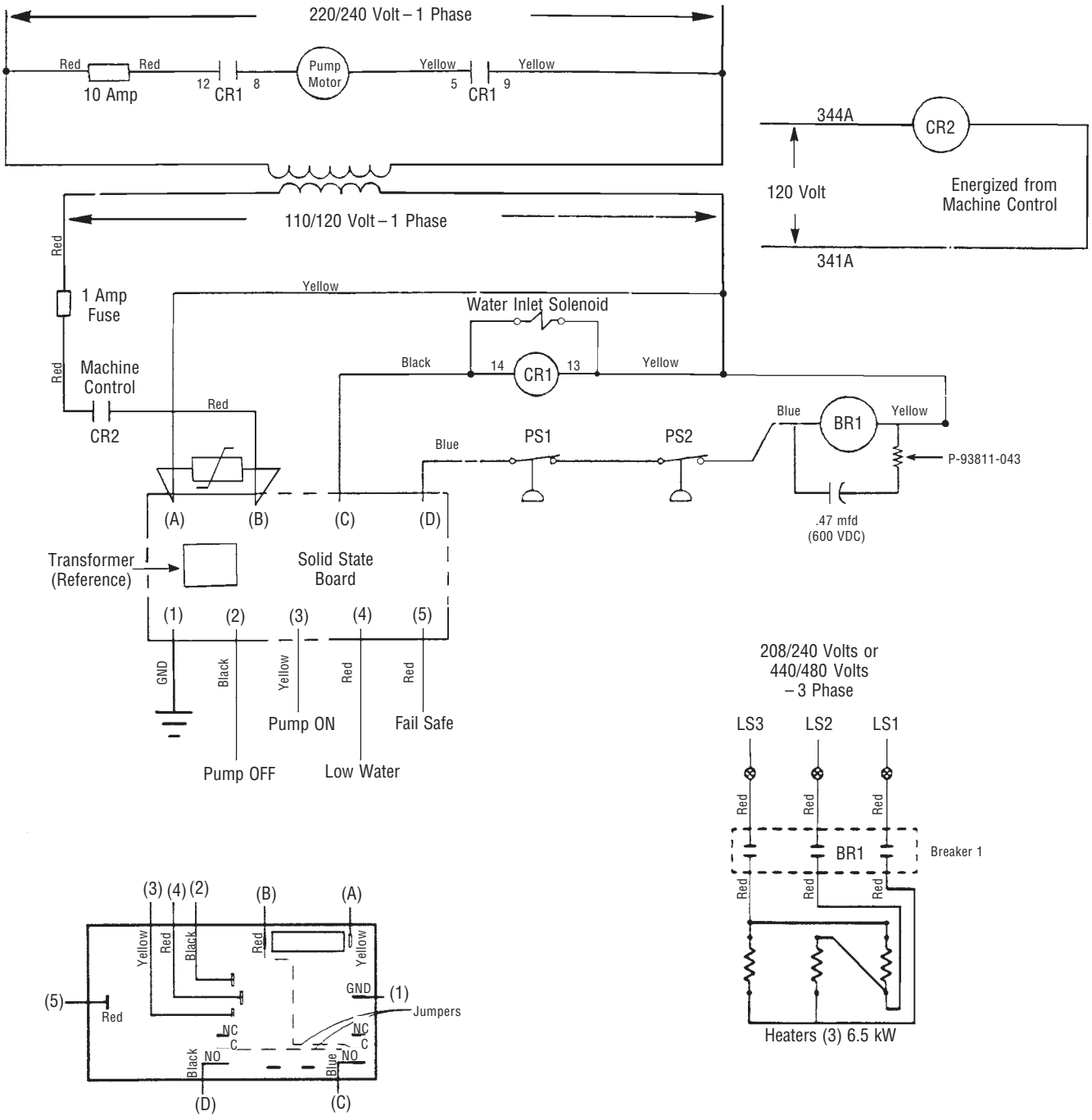


Figure 3-20. AS Series Solid State Control – Wiring Diagram (for units with one contactor and transformer).

3.7 OPERATION OF WARRICK SERIES 26 WATER LEVEL CONTROL

This control is used on many LB, LBAS, CES, and CHS steam generators.

3.7.1 Operation

Automatic Reset (reset terminals not used): When the liquid rises to the electrode on terminal LLCO, the control energizes, changing state of the load contacts (LED lit). The control remains energized until the liquid level recedes below electrode on terminal LLCO. The control then de-energizes (LED not lit), returning load contacts to original state. There is a five second time delay on decreasing level. Liquid must be below probe on terminal LLCO for full five seconds before control de-energizes.

Manual Reset (normally closed pushbutton installed across reset terminals): When the liquid rises to the electrode on terminal LLCO, the control remains de-energized until the pushbutton is depressed. The control energizes (LED lit), changing the state of the contacts. The control remains energized until the liquid level recedes below electrode on terminal LLCO. The control then de-energizes (LED not lit), returning load contacts to their original state. There is a five second time delay on decreasing level. Liquid must be below probe on terminal LLCO for full five seconds before control de-energizes.

Manual Reset Optional Power Outage Feature (normally closed pushbutton across reset terminals): Control will ignore power loss to control. With liquid above electrode on terminal LLCO, a power outage causes the control to de-energize, but automatically energizes upon return of power. However, loss of liquid causes control to de-energize and remains so until liquid again rises to electrode and pushbutton is depressed.

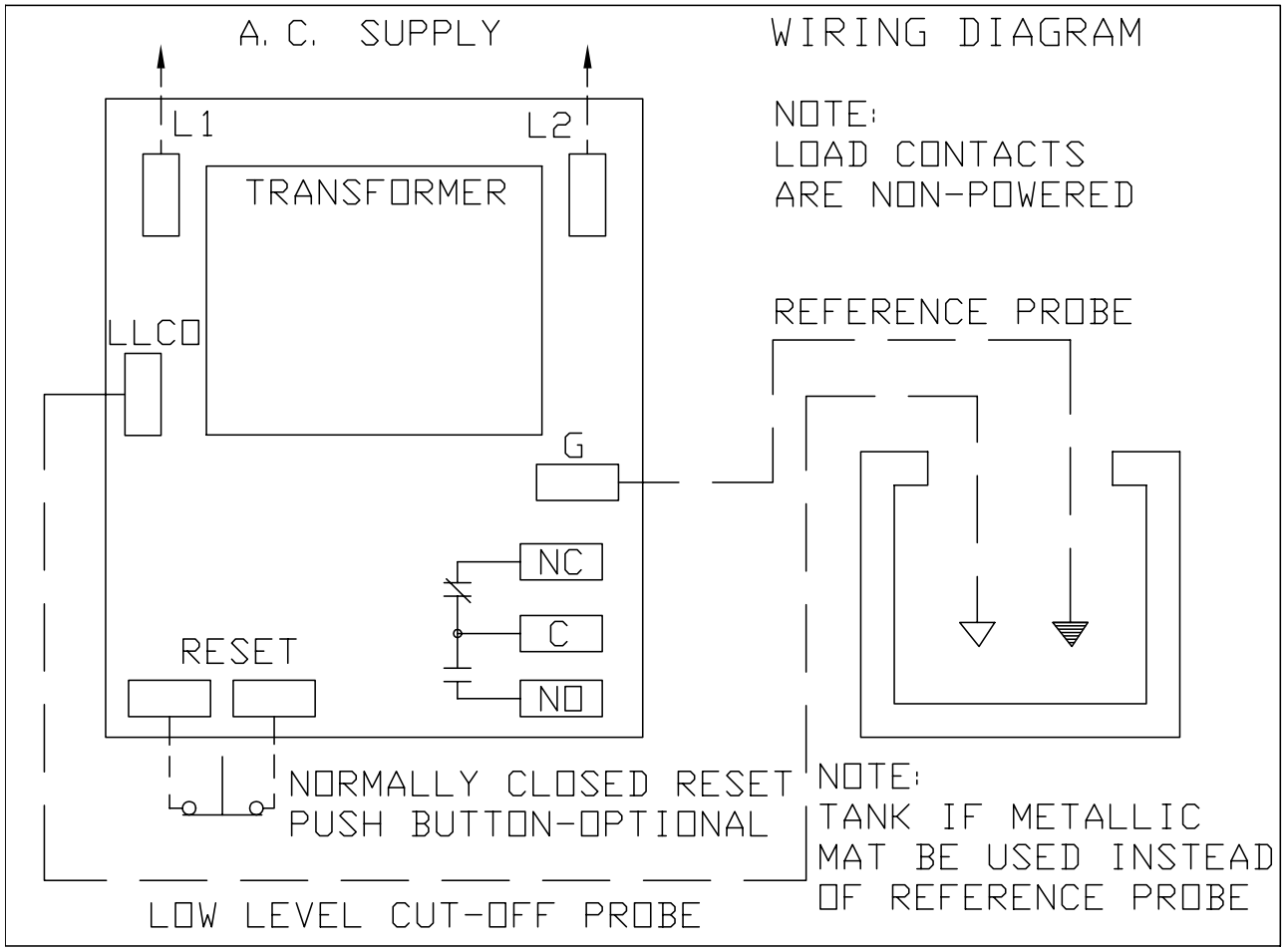


Figure 3-21. Wiring Diagram

3.8 OPERATION OF CHROMALOX WATER LEVEL CONTROL (323-300033-035)

This control is used on many CES series generators only.

3.8.1 Operation

The Chromalox Level Control (P-764326-194) performs three independent functions:

- The HLCO terminal provides high-level, anti-flood protection.
- The HP terminal provides a timed fill cycle for the feedwater device.
- The LLCO terminal provides the low level cutoff protection.

3.8.2 HLCO Function

Should a high-level condition occur and two seconds pass, the relay associated with the HLCO terminal de-energizes and locks out (LED off). The relay remains locked out until the level recedes below the probe and the normally open, high-level reset pushbutton is depressed (LED on).

The HLCO channel provides broken wire detection to the HLCO probe. Should either wire connected to the HLCO probe become disconnected and two seconds pass, the relay associated with the channel de-energizes and locks out (LED off). The relay remains locked out until the wires are reconnected and the HLCO reset pushbutton is depressed (LED lit).

NOTE: For proper operation, two wires must be utilized for the control to HLCO probe connections. Consult wiring diagram for more information.

If either of the ground/reference wires (G1 or G2) breaks or becomes disconnected, the HLCO relay immediately de-energizes and locks out (LED off). The relay remains locked out until the ground/reference wires are reconnected and the HLCO reset pushbutton is depressed (LED lit).

The HLCO channel provides power outage protection. The control ignores a power loss and returns to normal operation when the power returns; however, if the level has risen to the HLCO probe, the relay de-energizes (LED off) and locks out. The control remains locked out until the level recedes below the HLCO probe and the normally open button is depressed.

3.8.3 Fill Function:

When the level recedes below the HP (FILL) probe, the relay energizes to activate the feedwater device, filling the boiler (LED it). The boiler continues to fill until the level rises to the HP probe and five seconds pass. The relay de-energizes, cutting off the feedwater device (LED off).

NOTE: If the water level is on the HP probe at power up, the relay associated with the HP probe immediately de-energizes, shutting off the feedwater device.

Should ground wire G1 break or become disconnected, the fill relay will energize, turning on the feedwater device. The fill relay remains energized until the following three conditions are met:

1) The wire is reconnected.

2) The water is on the HP probe.

3) Five seconds have passed.

3.8.4 LLCO Function

Should the level recede below the LLCO probe and three seconds pass, the relay associated with the LLCO terminal de-energizes and locks out (LED off). The relay remains de-energized until the level is restored to the LLCO probe and the normally closed pushbutton is depressed (LED on).

The LLCO channel provides power outage protection. The control ignores a power loss and returns to normal operation when the power comes back on; however, if the level has receded below the LLCO probe upon power up, the relay associated with this channel de-energizes (LED off) and locks out.

Should the ground wire G1 break or become disconnected, the LLCO relay de-energizes (LED off). The relay remains de-energized until the wire is reconnected and the normally closed pushbutton is depressed.

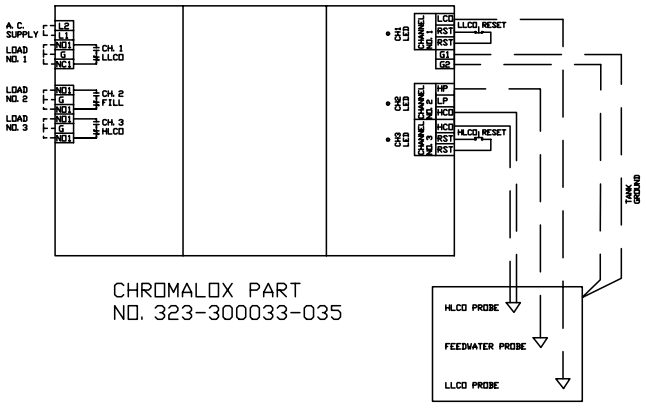


Figure 3-22. Wiring Diagram

STERIS

INSTALLATION, OPERATION

Electric Steam Boiler
Type CH02 – CH14

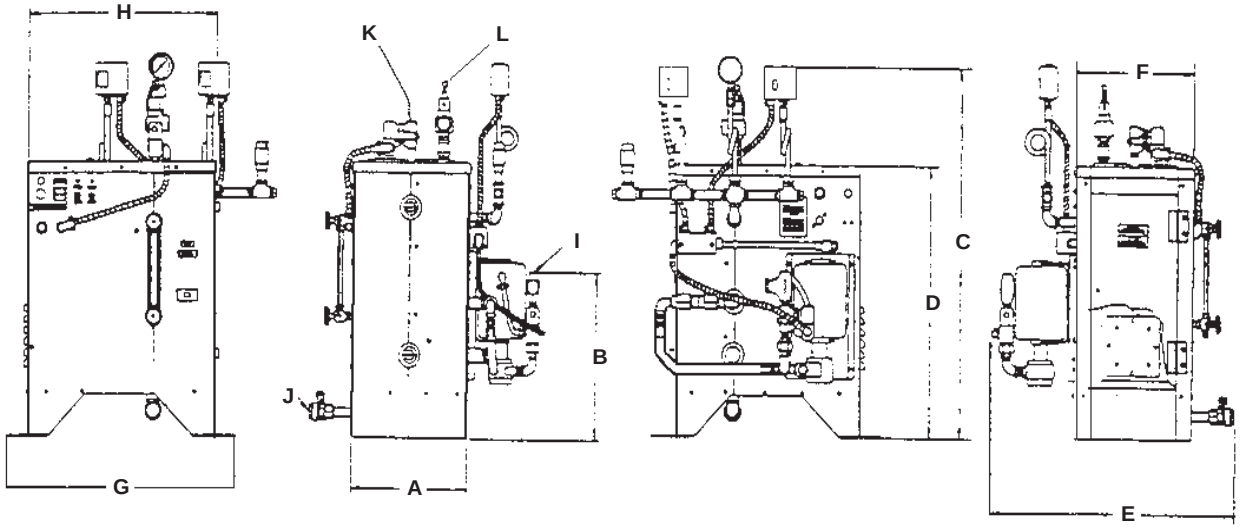
Standard Trim – 100 PSI
0-90 PSI Operation Pressure

Model Number _____	Power Circuit Voltage _____
Boiler Serial Number _____	Control Circuit Voltage _____
National Board Number _____	Amp _____ Ph _____ Cy _____
Customer to complete for future reference	

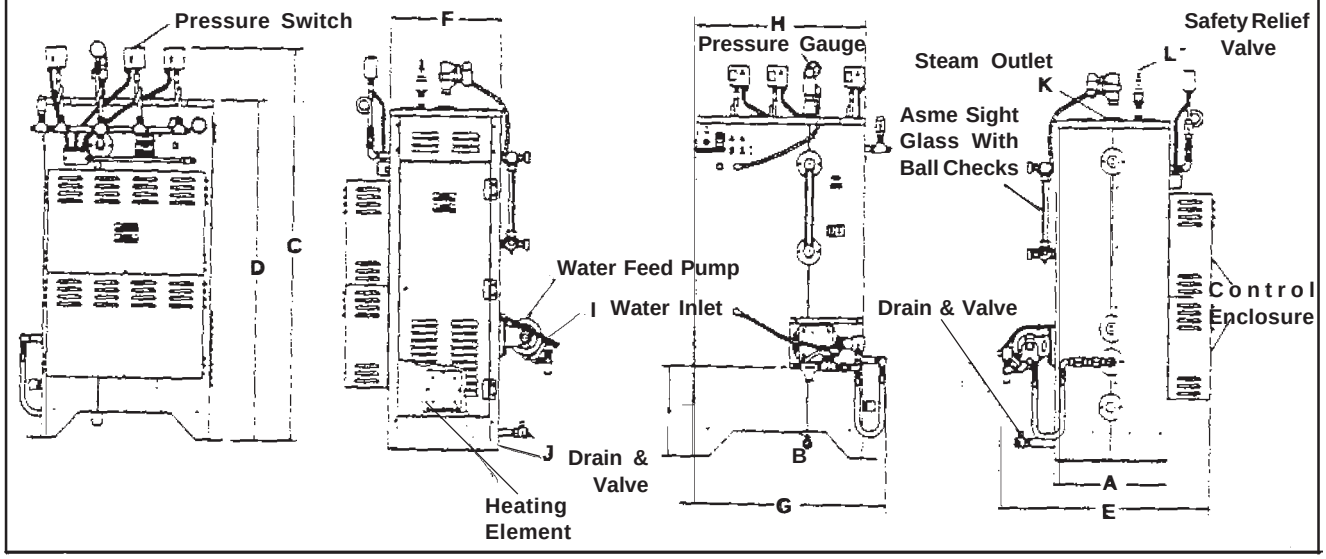
SPECIFICATIONS

Three Phase Voltage										
				Quantity and rating of contactors			Quantity and rating of heater fuses			
Catalog Number	kW	B.H.P. Rating	Output in lbs./hr at 80 psi with 140° F feedwater	208	240	480	208	240	480	No. and kW of heating elements
CH02	10	1	31.6	1-40	1-40	1-40	--	--	--	1-10 kW
CH03	15	1.5	47.4	1-50	1-40	1-40	3-60	--	--	1-15 kW
CH04	20	2	63.2	1-65	1-50	1-40	3-70	3-60	--	1-20 kW
CH05	30	3	94.9	2-50	2-50	1-40	6-60	4-45	--	1-30 kW
CH06	40	4.1	126.5	2-65	2-50	1-50	6-70	6-60	3-60	2-20 kW
CH07	60	6.1	189.7	4-50	4-50	2-50	12-60	12-50	6-50	2-30 kW
CH08	75	7.7	237.2	4-65	4-50	2-50	12-70	12-60	6-60	2-37.5 kW
CH10	102	10.4	322.5	6-50	6-50	3-50	18-60	18-60	9-60	3-34 kW
CH12	120	12.2	379.5	6-65	6-50	3-50	18-70	18-60	9-60	3-40 kW
CH13	150	15.3	474.3	8-65	8-50	4-50	24-70	24-60	12-60	4-37.5 kW
CH14	180	18.4	569.2	8-65	8-65	4-65	24-80	24-70	12-70	4-45 kW

MODELS CH 02 THROUGH CH 04



MODELS CH 05 THROUGH CH 14



DIMENSIONS (IN INCHES)

Catalog Number	A	B	C	D	E	F	G	H	I	J	K	L
CH02	12 -3/4	19 -1/2	35	27 -1/4	29 -11/16	12 -3/4	24 -3/8	20	1/ 2	1/ 2	1/ 2	1/ 2
CH03	12 -3/4	19 -1/2	35	27 -1/4	29 -11/16	12 -3/4	24 -3/8	20	1/ 2	1/ 2	1 /2	1/ 2
CH04	12 -3/4	19 -1/2	35	27 -1/4	29 -11/16	12 -3/4	24 -3/8	20	1/ 2	1/ 2	1 /2	1/ 2
CH05	15	4	43 -7/8	35 -7/8	30 -3/8	15	28 -5/8	24-3/16	1/ 2	1	3 /4	1/ 2
CH06	15	4	43 -7/8	35 -7/8	30 -3/8	15	28 -5/8	24-3/16	1/ 2	1	3 /4	1/ 2
CH07	15	4	43 -7/8	35 -7/8	30 -3/8	15	28 -5/8	24-3/16	1/ 2	1	3 /4	1/ 2
CH08	15	4	43 -7/8	35 -7/8	30 -3/8	15	28 -5/8	24-3/16	1/ 2	1	3 /4	1/ 2
CH10	18	17 -5/8	60	50 -7/8	34 -1/4	18	33 -1/8	27 -3/16	1/ 2	1	1	3/ 4
CH12	18	17 -5/8	60	50 -7/8	34 -1/4	18	33 -1/8	27 -3/16	1/ 2	1	1	3/ 4
CH13	18	17 -5/8	60	50 -7/8	34 -1/4	18	33 -1/8	27 -3/16	1/ 2	1	1	3/ 4
CH14	18	17 -5/8	60	50 -7/8	34 -1/4	18	33 -1/8	27 -3/16	1/ 2	1	1	3/ 4

INSTALLATION

WARNING - Hazard of electrical shock and severe burn: Injury or death may occur if this equipment is not properly installed and operated. The boiler must be grounded using the grounding means provided and be wired in accordance with the National Electrical Code by a qualified person after reviewing the installation and operating instructions for your electric steam boiler.

NOTE: When installing the boiler, allow sufficient room (18 inches minimum) to allow removal of the heating element if and when necessary.

1. The boiler should be mounted on a solid, level foundation, near floor drain. Provisions should be made to prevent damage in the event the boiler leaks water or discharges steam.
2. A minimum distance of 18 inches between the boiler and any combustible material must be maintained.
3. Complete all piping to the boiler. Connect the water line to the fitting on the pump and the motor assembly.
4. When using any type of water feed other then the pump feed provided with the boiler, the incoming water supply must be 10 psig greater then the operating pressure of the boiler. This is required to maintain a proper water level in the boiler. Failure to maintain the proper water level may cause heater failure. Keep the feed water line valve open at all times except during blowdown.
5. Connect the steam line, using a globe valve, to the boiler steam outlet. The valve should be placed as close as possible to the boiler outlet and sized per the label on the boiler.
6. To maximize the efficiency, all steam piping from the outlet should be insulated.
7. Drain and relief valve piping should be installed in accordance with state and local codes.
8. Only a qualified person, aware of local and national electrical and plumbing codes, should install this equipment.

WATER SPECIFICATION

STERIS recommends supplying the boiler with hot water at 140° F or 60°C, (Maximum 150°F or 65°C) to minimize the heat-up time and conserve electricity. Colder water can be used but will result in a longer heat-up time and reduced steam output.

Feed water varies considerably with site location. For proper boiler operation and reasonable element life, STERIS recommends the feed water quality be controlled within the following parameters.
The recommended total hardness should be 0-17 mg/l, specific resistance not to exceed 26,000 Ω/cm with pH maintained between 6.8 and 7.5. Total dissolved solids should not exceed 250 PPM and alkalinity (bicarbonate only) should not exceed 180 PPM as calcium carbonate.

If the available feed water source does not meet the above requirements, contact a water treatment company for recommendations for water supply modifications. Failure to supply water within the above specifications may decrease the boiler life and may cause failures not covered by equipment warranty.

ENGINEERING DATA

Rating (kW)	10	15	20	30	40	60	75	102	120	150	180
Boiler Horsepower	1	1.5	2	3	4.1	6.1	7.7	10.4	12	15.3	18.4
Steam output in lbs./hr at 80 psig with 140° F feedwater	31.6	47.4	63.2	94.9	126.5	189.7	237.2	322.5	379.5	474.3	569.2
Gross output in BTU/hr	34,120	51,180	68,240	102,360	136,480	204,720	255,900	348,024	409,440	511,800	614,160
Approx. operating weight in lbs. (kg)	230 (104)	230 (104)	230 (104)	400 (181)	410 (186)	420 (190)	430 (195)	940 (425)	945 (428)	950 (430)	960 (434)
Electrical consumption in Amps											
208 Volt, 3 Phase	28	42	56	83	111	167	210	283	333	416	500
240 Volt, 3 Phase	24	36	48	72	96	144	180	245	289	361	433
480 Volt, 3 Phase	12	18	24	36	48	72	90	123	144	180	217
Water consumption in gph (lph) at Steam output of 80 psi with 140 F feedwater	3.8 (14.4)	5.7 (21.6)	7.6 (28.8)	11.5 (43.5)	15.2 (57.5)	22.7 (85.9)	28.4 (107.5)	38.7 146.5	45.5 (172.2)	56.9 215.4	68.2 (258.1)
Approx. heat loss in BTU/hr at 70°F ambient continuous operation	850	850	850	1750	1750	2600	3500	4400	4800	4800	4800

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Section 4: Preventive Maintenance

4.0 GENERAL

A regular preventive maintenance program pays dividends in longer equipment life and less downtime for costly repairs. For this reason, the importance of the maintenance instructions provided in this section cannot be overemphasized.

All preventive maintenance for the electric generator is outlined in Table 4-2. Table 4-2 gives the recommended minimum intervals between procedures. Because water conditions and user applications vary, generator operation may indicate the need for more frequent maintenance than the minimum suggested in the chart. The user must judge whether more frequent preventive maintenance is necessary. Maintenance procedures which require special skills should be performed by qualified personnel. Some of the maintenance procedures described in this section could be dangerous to maintenance personnel if the following precautions are not observed. Unless specifically stated otherwise, take the following precautions:

- Always allow the steam pressure to drop to zero and the unit to cool.
- Completely disconnect the unit from the power source before servicing.
- Always observe lockout/tag-out procedures.

4.1 HEATING ELEMENT AND BOILER CHAMBER CLEANING

⚠ WARNING – PERSONAL INJURY HAZARD: Verify that generator pressure gauge indicates "0" psig before proceeding.

1. Allow the generator to cool and drain completely.

NOTE: Generator drain valve to remain OPEN.

2. Lockout/tag-out the 3-phase and 1-phase power source from the generator at the wall box following an approved procedure.
3. Carefully tag each lead on the heating element terminals of the first element so they can be returned to the original terminals later.
4. Remove the leads from the heating element of the first element.

NOTE: Do not remove the strapping bars from the heating element terminals.

5. Remove the bolts/nuts which secure the heating element to the boiler and carefully slide the heating element out of the boiler.
6. Clean the heating element and the inside of the boiler chamber with a wire brush to remove any mineral deposits or scale.

⚠ CAUTION – POSSIBLE EQUIPMENT DAMAGE: Do not use power tools or chipping motion when cleaning heating elements as this may damage element tube wall.

7. Reinstall the heating element with a new heating element gasket in the boiler chamber. Alternately tighten the mounting bolts/nuts as indicated on the instructions supplied with the gasket (see also Section 6).
8. Reconnect the leads to the heating element terminals.
9. Perform steps 3 through 8 for each additional heating element.
10. Tag each lead on the control electrode(s) so they can be returned to the original terminals later.
11. Remove the leads from the electrodes.
12. Remove the electrode(s) and clean with a wire brush or sandpaper.
13. Reinstall electrode(s) and electrode lead(s), assuring that each lead is reconnected to the correct electrode.
14. CLOSE generator drain valve.
15. Reconnect 3-phase and 1-phase power source.

4.2 STEAM CHAMBER DESCALING/ FLUSHOUT USING STERIS DESCALER (CAT. NO. 105108)

1. Remove scale buildup from inside of boiler as described in paragraph 4.1 and note approximate amount of overall scale buildup.
2. For generators with automatic flush and drain:
   a. Start the generator using normal start up procedure to flush out loose sediment. (See 3.1.)

   b. Immediately after flushing (when generator fills to its proper operating level), turn generator OFF and remove automatic flush and drain relay from its base.

NOTE: It is necessary to by-pass the Automatic Flush and Drain cycle during descaling to prevent the unit from flushing out the descaler when the generator is turned ON again.

3. For generators without automatic flush and drain:
   a. Start the generator using normal startup procedure to flush out loose sediment.
   b. Immediately after flushing, when generator fills to its proper operating level, turn generator OFF.
4. Make sure that the generator is cool and pressure gauge is at 0 psig, and remove the pipe plug in the steam outlet discharge line safety valve.
5. Insert funnel into opening and very slowly pour in10 oz. of STERIS Descaler (Cat. No. 105108) for every gallon of water in the generator (see Table 4-1). Be careful of fumes. Vent properly while pouring.

TABLE 4-1

Generator Model Number	Operating Water Capacity
LB AS	3.5 gal
LB10-15	4.0 gal
LB20-25	6.5 gal
LB40-60	8.0 gal
LB80-180	25.0 gal
Boiler Model Number	**Operating Water Capacity**
CH02-04	3.0 gal
CH05-08	7.0 gal
CH10-14	18.0 gal

6. Reinstall pipe plug or safety valve.
7. CLOSE steam outlet valve and allow the descaler solution to remain in the generator for 60 minutes (1 hr.).
8. Turn generator ON until 5 psig steam pressure shows on generator pressure gauge.
9. Turn generator OFF and let stand for at least 1/2 hour or until generator pressure gauge shows 0 psig.
10. For units with automatic flush and drain:
    a. Replace flush and drain IDEC relay removed above.
    b. Turn generator ON in normal manner and allow generator to flush for preset three minutes, at which time generator refills to normal operating level.
    c. Turn generator OFF.
11. For units without Automatic Flush and Drain:
    a. OPEN generator drain valve.
    b. Turn generator ON in normal manner and allow to flush for three minutes.
    c. CLOSE generator drain valve and allow to refill to normal operating level.
    d. Turn generator OFF.
12. Repeat either step 10 (for units with automatic flush and drain) or step 11 (for units without automatic flush and drain) a total of four more times.
13. Generator is now ready for normal use and operation.

TABLE 4-2. PREVENTIVE MAINTENANCE CHECKLIST

This schedule is to be followed for proper operation of electric generators. Some operating conditions (high usage, poor water quality) may require more frequent inspections.

NOTE: This Preventive Maintenance Checklist covers both the integral and stand-alone generators.

	PROCEDURE	FREQUENCY
1.0	**PREPARATION FOR PREVENTIVE MAINTENANCE**	
NOTE: Unit must be cold to perform Preventive Maintenance, unless blow down (hot) is required.		
2.0	**CHAMBER FLUSH/BLOWDOWN/DESCALE**	
2.1	Flush/Blowdown unit, whichever is required	Each
2.2	Descale	3 x / yr
NOTE: More frequent descaling may be necessary depending on local water quality and frequency of flush/blowdown performed by the customer per recommended maintenance procedures described in the Operator Manual.		
3.0	**VALVES**	
3.1	Verify each hand (ball) valve operates easily, check valve packing for leaks, rebuild or replace as needed.	
	Water supply valve	Each
	Pressure gauge valve	Each
	Water column drain (if equipped)	Each
	Blow down	Each
3.2	Replace check valve(s)	2 X / yr
3.3	Replace safety valve	1 X / yr
3.4	Rebuild steam solenoid valve (if equipped)	2 X / yr
3.5	Rebuild water solenoid valve	2 X / yr
4.0	**MISCELLANEOUS PIPING COMPONENTS**	
4.1	Inspect strainer for debris, clean as needed.	Each
4.2	Pressure gauge (0-160 psig)-Verify proper operation. Replace if needed.	Each
4.3	Pressure switches - Verify proper setting and operation.	
	Control	Each
	Safety (Check manual reset)	Each
	PS1 (if equipped)	Each
5.0	**SIGHT GLASS ASSEMBLY**	
5.1	Check for signs of cracking, leaking.	Each
5.2	Replace sight glass, washers, and valves.	2 X/yr
6.0	**WATER LEVEL CONTROL SYSTEM**	
6.1	Verify proper operation.	Each
6.2a	Clean water level control rods (carbon-steel units).	3 X / yr
6.2b	Clean water level floats (stainless-steel units).	3 X / yr

7.0	FINAL CHECKOUT AND TEST	
7.1	Verify that unit has proper labels (caution, warning).	Each
7.2	Replace any blown fuses or burned out lamps as needed.	Each
7.3	Check fuses and fuse clips for signs of deterioration or arcing.	Each
7.4	Check heater contactors for signs of arcing.	Each
7.5	Start up generator. Verify correct water fill level, operating pressure, come-up time, etc.	Each
7.6	Test flood alarm system (if equipped).	Each
7.7	Reinstall any panel or cover removed. Check area to ensure removal of all materials used during inspection.	Each

4.3 LB AND LBAS CONTROL FLOAT CLEANING (Four-digit Serial Numbers)

1. Allow generator to cool completely and disconnect the electrical power source from the generator.
2. Remove the screws from the cover of the junction box on the water-level control.
3. Remove the lower cover of the junction box by lifting up on the end and unhooking it from the lip on the upper cover.
4. Carefully tag the wires with small pieces of tape so they can be returned to their original terminals; then remove the wires from the terminal strip.
5. Remove the conduit from the junction box of the water-level control.
6. Loosen eight bolts and carefully slide the head assembly and float out of the float chamber.
7. Clean the float chamber and interconnecting piping with a small wire brush.
8. Replace the head assembly on float chamber, using a new gasket. Tighten bolts evenly.
9. Reconnect the wiring to the junction box terminal strip and replace the cover.

4.4 LB AND LBAS CONTROL ROD CLEANING (Five-digit Serial Numbers)

The three (or four) rods controlling the chamber water level are contained within the control head located on top of the generator cabinet. These rods are connected to spark plugs which, in turn, are connected to the generator electrical control circuit. Clean the water-level control as follows:

1. Disconnect the electric power source from the generator; allow it to cool completely.
2. Remove the four screws from the cover of the water-level control head.
3. Remove the cover.
4. Carefully identify both the wires and spark plugs with small pieces of tape so that they can be returned to their original locations. Then remove the wires from the spark plugs.
5. Remove the spark plugs, complete with rods, from the control head. Thoroughly clean rods of all lime or other deposits with a small wire brush. Then replace the rods and spark plugs in their original locations and tighten connections.
6. Reconnect wiring to their respective spark plugs and replace cover.

4.5 BLOWDOWN (HOT)

WARNING – BURN HAZARD: During this procedure, the boiler piping is hot and water is released under pressure and should be connected to a receiver capable of withstanding 260°F (127°C). To prevent burns, wear protective gear and use caution.

WARNING – BURN HAZARD: Steam and boiling hot water will exit the drain under pressure. Proper safety attire (gloves, eye protection, insulated overall) are necessary.

1. Position control power switch to the ON position until approximately 20 psig is indicated on boiler pressure gauge.
2. Disconnect high voltage 3-phase power to protect heaters.
3. Slowly open boiler drain valves by turning the handle counterclockwise 90°.
4. Allow the boiler to blowdown for two to three minutes. The boiler pump will come on during this time.
5. Close drain valve. The boiler will refill with water.
6. Position power switch to OFF.
7. Reconnect high voltage 3-phase power.
8. The boiler is now ready for normal use and operation.

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Section 5: Troubleshooting

General – This section is intended to aid both the operator and qualified service personnel in locating trouble in the steam generator. When specific symptoms are known, the troubleshooting charts can be used to suggest the probable cause and corrective action. When no symptoms are known, performing a systematic operational check as described in paragraph 4.3 is the best approach. When trouble is suspected within the heating elements, the voltage and current data provided in paragraph 5.2 will be helpful.

5.1 TROUBLESHOOTING CHART

The troubleshooting charts in Table 5-2 (for LB Series and LBAS Series Non-solid State), Table 5-3 (for LBAS Series Solid State Control), and Table 5-4 (for CHS and CES series) list symptoms and their associated probable causes and remedies. The causes are listed in the order of most probable occurrence. Always begin by checking the first cause listed after a symptom, working down in order until the actual cause is determined.

5.2 HEATING ELEMENT VOLTAGE AND CURRENT DATA

⚠ WARNING - ELECTRIC SHOCK AND BURN HAZARD: Voltages normally present in the steam generator are dangerous and may be fatal, if contacted. Use extreme care when making voltage and current measurements on live circuits.

When trouble is suspected with the heating elements, measure the voltage at the supply line side of the contactor terminals and also the heating element terminals, since low voltages can cause slow heating and high voltages can cause premature heating element failures. After checking the voltages, measure the current required by each heating element. Acceptable voltage readings associated with improper current readings indicate a defective heating element. Data for single-phase units is found in Tables 5-5 or 5-6; data for three-phase units is provided in Tables 5-7 or 5-8; and data for LBAS Series Solid State Control is in Table 5-9. Be sure to use the data which applies to the specific heating element being tested. Refer to the applicable wiring diagram in Section 6 for circuit details when making voltage and current measurements. Check to make certain that unit is grounded to an appropriate grounding electrode in accordance with the latest edition of N.E.C.

5.3 LB AND LBAS SOLID STATE CONTROL

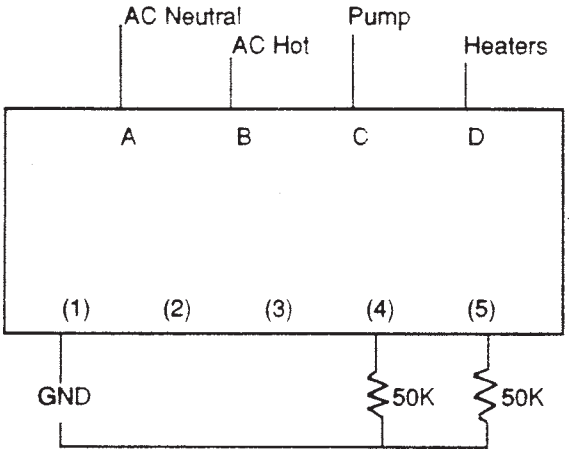
Problems with the generator may be blamed erroneously on the control. Before replacing the control, verify the water-level control rods are clean and are the correct length. Also, verify that water hardness is a maximum of 7 grains, which is necessary for control rods to sense ground correctly. Distilled or deionized water does not have sufficient conductivity to allow the water-level control to function properly. If these items have been checked, evaluation of the control board is the next step. Use a voltmeter and several resistors to check the control board as follows. Refer to applicable wiring diagram in Section 6. Four 50K resistors are needed; they can be obtained from a local electronics supplier (e.g., Radio Shack).

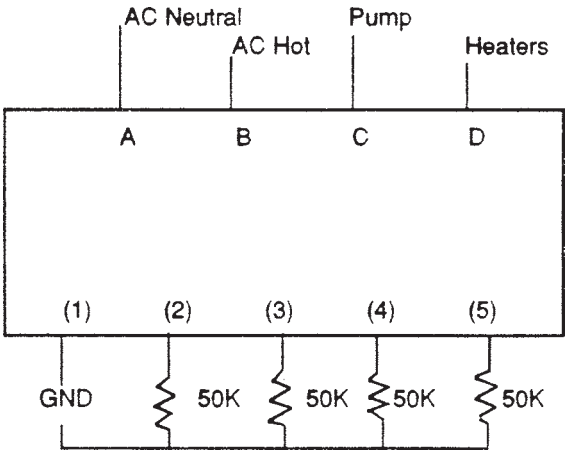
1. Turn OFF 3-phase breaker supplying power for the heaters.
2. Turn OFF water supply valve to the generator.
3. Drain all water from the generator.
4. Turn OFF sterilizer control power.
5. With power off, remove wires from terminals labeled C, 2, 3, 4, and 5.
6. Verify terminal 1 is connected to chassis ground.
7. Turn sterilizer control power (110 VAC) back ON. Verify terminals A and B are connected to 110 VAC neutral and hot respectively.
8. Momentarily connect the black wire to terminal C. The pump should turn on. This is the signal from the control to turn on the pump to fill the unit with water. Since the level probes are disconnected, the control sees no water and tries to fill. If voltage is not present, replace the control. Disconnect the wire to prevent damage to the pump.
9. Check to see that the heater contactors are not energized. Since the water-level probes are disconnected, the control sees no water so the heater circuit should be off. If the contactors are on, replace the control.
10. Using two 50K resistors, connect terminals 4 and 5 to terminal 1 as shown on Figure 5-1. This simulates the low water and fail-safe probes being under water. Check that the heater contactors are energized. The control energizes the heater contactor

circuit whenever the low water and fail-safe probes sense water. (The actual cycling of the heaters is controlled by pressure switches [see wiring diagram].)

11. Connect two 50K resistors as shown in Figure 5-2. This simulates that the generator is full of water. Reconnect the black wire to terminal C; the pump should not turn on. If the pump comes on, replace the control. Leave the black wire in place.
12. Remove the resistor from terminal 2. The pump should remain off. Remove the resistor from terminal 3. The pump should turn on. Remove the black wire from terminal C to prevent damage to the pump. This procedure simulates the water-level control system sensing a need for water.

If the control passes this procedure, a problem in the generator is not due to a malfunctioning control. Problems with the water-level control system would generally be due to the inability of the level probes to correctly sense water. The probes must be clean of all oil or scale buildup. The water being fed to the generator must be a maximum of seven grains hardness or the water level control will not sense properly. This situation may occur if purified or excessively softened water is supplied.





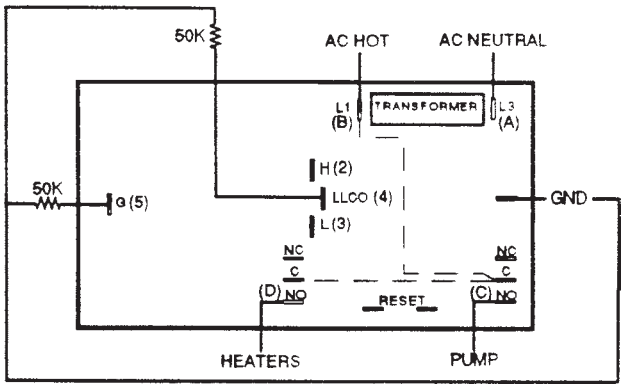


Figure 5-1. Simulating Low Water and Fail-Safe Probes Being Under Water

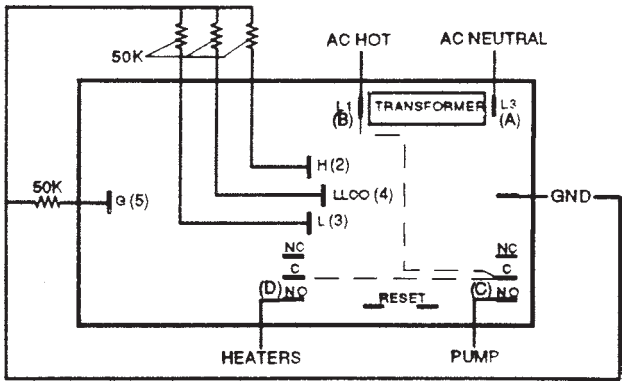


Figure 5-2. Simulating Generator Full of Water

TABLE 5-1.
HEATER FAILURE TROUBLESHOOTING (Applies to All Units)

	Heater Element Condition	Probable Cause
1.	Water leakage at heater flange.	1. Heater bolts improperly tightened. Refer to flange tightening instructions. 2. Debris on heater flange of generator flange surface. Clean prior to installation. 3. Heater bolts not retorqued after initial operation. Refer to flange tightening, instructions.
	Heater Element Condition	**Probable Cause**
2.	Water leakage at heater element to flange junction.	1. Faulty weld or braze on element to flange connection – or corrosion. 2. Verify water is not exiting through heater terminal. Normally seen in condition #5.
	Heater Element Condition	**Probable Cause**
3.	Burned wiring connections.	1. Loose wire connections. Tighten property after inspection. 2. High resistance in wire connection due to oxidation. Clean wires before reconnecting to element. Replace if necessary.
	Heater Element Condition	**Probable Cause**
4.	Heater element has open circuit. (Element looks OK but Ohmmeter check shows infinite resistance.)	1. Element has open circuit due to normal wear and tear to end life. 2. If generator is undersized for its application, heaters will be overworked and reach end of life sooner. 3. Element has been overheated due to excessive scale build up. The scale acts as an insulator retarding heat transfer to the water. Short element life will result. If significant scale is observed on element, a need for more frequent blowdown/ flushing or descaling is indicated. 4. Wrong voltage supplied to element. 5. Element not totally immersed in water. This causes a localized hot spot which melts the wire inside the element. Cause of problem is fault in water level control system. Elements damaged in this way may be distorted. Repair and verify operation of the level control prior to restarting the heater.

(continued)

TABLE 5-1.
HEATER FAILURE TROUBLESHOOTING (Applies to All Units) (CONTINUED)

Heater Element Condition	Probable Cause
5. Heater element has developed a ground fault. When this occurs, a hole may be formed in the sheath material, allowing water to enter the element.	1. Corrosion of heater element sheath – use of corrosive descaler compounds will etch sheath. Use only approved descaler to remove scale. 2. Element has overheated due to excessive scale build up. This can cause localized hot spot which sometimes arcs through insulation and the ground metal sheath. More frequent blowdown/ flushing or descaling is needed. 3. Element not totally immersed in water. This causes a localized hot spot which produces a hole in sheath. Cause of problem is fault in water level control system. Elements damaged in this way may be distorted. 4. Excess vibration. Vibration could cause rubbing of elements, wearing a hole in the sheath. Vibration could be caused by large machinery nearby. 5. Wrong voltage supplied to element.

TABLE 5-2.
TROUBLESHOOTING CHART–LB SERIES AND LBAS SERIES NON-SOLID STATE

NOTE: This troubleshooting chart applies to units with automatic flushing. When troubleshooting a unit without automatic flushing, disregard symptoms or causes which apply to timer, solenoid drain valve, or flushing operation.

Symptom	Probable Cause	Corrective Action
Generator does not fill and does not heat.	Main electric disconnect box in building turned off.	Turn on main electric switch.
	Valve from city water line closed.	Open valve.
	Drain valves open (units without automatic flushing only).	Close valves.
	Control circuit fuses in generator faulty.	Clear control circuit and replace fuses
	Water strainer clogged.	Clean water strainer
	Timer motor or timer switches defective.	Replace timer.
	Solenoid drain valve seat obstructed.	Disassemble valve and clean valve seat.
	Water-level switch defective.	Repair or replace water-level switch
	Defective TG relay.	Replace TG relay.
Symptom	**Probable Cause**	**Corrective Action**
Generator fills and heats but does not flush.	Main electric disconnect switch turned off before timer could reset time after last flush cycle.	Reset timer by turning pilot toggle switch off for 3 minutes, with main electric switch off.
	Timer motor or switch defective.	Replace timer.
	Solenoid drain valve defective.	Repair or replace solenoid drain valve.

TABLE 5-2.
TROUBLESHOOTING CHART–LB SERIES AND LBAS SERIES NON-SOLID STATE (CONTINUED)

NOTE: This troubleshooting chart applies to units with automatic flushing. When troubleshooting a unit without automatic flushing, disregard symptoms or causes which apply to timer, solenoid drain valve, or flushing operation.

Symptom	Probable Cause	Corrective action
Generator does not come up to pressure within 10 minutes.	Steam output valve open.	Close valve.
	Heating element fuses or fuse connections defective	Clear heating element circuit and replace fuses
	Points, connections, or magnetic contactor defective.	Repair connections or replace defective parts.
	Timer motor or timer switches defective.	Replace timer.
	Heating element defective.	Check heating element
	Check valve defective.	Clean or replace defective check valve
Symptom	**Probable Cause**	**Corrective Action**
Generator comes up to pressure but puts out no steam.	Steam output valve closed.	Open valve.
	Steam line, valves, and traps between equipment and generator set in wrong position, or defective.	Clear Steam Line.
Symptom	**Probable Cause**	**Corrective Action**
Generator boiler floods.	Solenoid valve seat obstructed.	Disassemble valve and clean valve seat.
	Water-level control defective.	Repair or replace water-level control.
	Defective TG relay.	Replace TG relay.
	Water has insufficient conductivity.	Feedwater must be 0-7 grains hardness.
Symptom	**Probable Cause**	**Corrective Action**
Improper pressure-differential cycle.	Pressure switch out of adjustment or defective.	Adjust pressure control or replace if defective.

TABLE 5-3.
TROUBLESHOOTING CHART–LBAS SERIES SOLID STATE

Symptom	Probable Cause	Corrective Action
Generator does not fill and does not heat.	Main electric disconnect box in building turned off.	Turn on main electric switch.
	Valve from city water line closed.	Open valve.
	Drain valve open.	Close valve.
	Control circuit fuses in generator faulty.	Clear control circuit and replace fuses
	Water strainer clogged.	Clean water strainer.
	Water level probe defective.	Repair or replace water-level probe.
	Defective water-level control PC board.	Replace PC board.
	Defective CR1 relay.	Replace relay.
Symptom	**Probable Cause.**	**Corrective Action**
Generator does not come up to pressure within 10 minutes.	Steam output valve open.	Close valve.
	Points, connections, or magnetic contactor defective.	Repair connections or replace defective parts.
	Heating element defective.	Check heating element
	Check valve defective.	Clean or replace defective check valve.
Symptom	**Probable Cause**	**Corrective Action**
Generator comes up to pressure but puts out no steam.	Steam output valve closed.	Open valve.
	Steam line, valves, and traps between equipment and generator set in wrong position.	Clear steam line.
Symptom	**Probable Cause**	**Corrective Action**
Generator boiler floods.	Solenoid valve seat obstructed.	Disassemble valve and clean valve seat.
	Water level control probes defective.	Replace water-level probes.
	Water has insufficient conductivity.	Feedwater must be 0-7 grains hardness.
	Defective water level control PC board.	Replace PC board.

TABLE 5-3.
TROUBLESHOOTING CHART–LBAS SERIES SOLID STATE (CONTINUED)

Symptom	Probable Cause	Corrective Action
Improper pressure-differential cycle.	Pressure switch out of adjustment or defective.	Adjust pressure control or replace if defective.
Symptom	**Probable Cause**	**Corrective Action**
Excessive generator noise.	High water flow rate to pump.	Replace 2 GPM flow control valve (P-76044-091) between water inlet solenoid and pump.
Symptom	**Probable Cause**	**Corrective Action**
Solid state control malfunction.		See separate troubleshooting information

TABLE 5-4.
TROUBLESHOOTING CHART - CHS AND CES SERIES

PROBLEM	CAUSE	ACTION TO TAKE
Control power light off.	Control fuse blown.	Check and/or replace control fuse.
	Control power off.	Check breaker or main power feed.
Boiler does not run. Control power light on.	Flood alarm enabled.	Reset flood alarm.
	High limit pressure switch tripped.	Reset manual pressure switch. Check switch setting. Adjust to 10 psig higher than operating control switch setting. Adjust manual reset switch differential to minimum setting. If switch continues to trip, it may be due to a faulty control switch or a faulty heater contactor.
Intermittent false flood alarms, boiler water level normal.	Loose connections on dual lead wires to flood probe.	Check all terminations and lead wires on the flood control board and probe.
	Boiler priming (foaming) caused by high alkalinity and dissolved solids in the boiler water (soft water).	Provide for daily blowdown or increase frequency of drain and flush cycle to reduce contamination in boiler water.
	High level probe in wrong location. Unit has antiflood probe in top of tank or in "Y" branch at steam outlet.	Check for proper location of flood probe. Probe should not be in tank or in steam outlet line piping. Order side arm water column kit to remove flood probe from steam outlet. P755716-180 for 10-20 kW, P755416-181 for 30-75 kW, P775716-182 for 100-180 kW.
Pump short cycles. Boiler fills erratically.	Inductive signal from power leads causing control to short cycle.	Separate probe lead wires (blue and yellow) on water level probe to water level control board from other wires in the harness assembly.
Threaded connection leak after several weeks of operation.	Expansion and contraction of piping loosens threaded connections.	Retighten threaded joints. Disassemble re-dope pipe threads and reassemble.
	High alkalinity in boiler water attacks pipe sealant and metal.	Maintain boiler water quality with proper blowdown and drain and flush cycles (soft water). Increase frequency of boiler maintenance.
Frequent or continuous flood alarms, boiler actually flooded.	Loose connection on water level probe.	Check all connections and wiring to water level control board and probe.
	Damaged or overloaded motor starter relay (stuck contacts).	Check motor relay contacts for burning or arcing.
		Check feed water pressure and supplies (20-50 psig dynamic under load). Make sure pump motor is not stalling at start-up, overloading the relay contacts. Replace 10A/13A relay with 15A relay P764322-763.
		Separate probe lead wires on water level probe to water level control board from wires in the harness assembly.
	Faulty water inlet solenoid valve.	Rebuild solenoid valve.
	Scale formation on water level control probe (carbon steel units).	Clean probe. Improve maintenance on boiler by more frequent blow down and descaling. Check water hardness: should be 0-7 grains maximum.

(continued)

TABLE 5-4.
TROUBLESHOOTING CHART - CHS AND CES SERIES (CONTINUED)

PROBLEM	CAUSE	ACTION TO TAKE
Frequent or continuous flood alarms, boiler actually flooded. (continued)	Faulty water level control board.	Replace water level control board.
	Water has insufficient conductivity to activate control probe (carbon-steel units).	Check water resistance (conductance). Maximum resistance is 26K ohms.
	Water level probe missing (carbon-steel units).	Check water level probe inside tank to make sure it is in place. Check isolator tube for corrosion or physical damage.
	Faulty water level float (stainless-steel units).	Replace/repair float.
	Condensate from steam line running back into boiler.	Check for proper steam traps in steam line to remove or control condensate. Install check valves in steam lines on boilers operated in parallel.
Pump starts (power) but does not run or fill.	Pump damaged or seized.	Check to see that the pump is a high temperature model.
	Check valves leaking steam back into pump.	Provide double check valves in the feed water piping between the pump and the boiler tank.
	Water supply line pressure too low.	Check feed pressure and supply. Should be 20-50 psig dynamic (under load).
No water in sight glass. Pump does not start.	Shorted water level probe.	Check lead wires and terminal connection on probe. Make sure terminal is not shorted to the sheet metal enclosure (top panel). Check probe rod inside tank. Probe rod may be shorted to the isolator tube inside the boiler tank.
	Boiler flood control tripped.	Reset control. Refer to corrective action above for actual flood condition.
	Water level control board inoperative.	Functionally check control board. Manually activate probe circuit using jumper wires and observing control relay functions.
	Motor or pump failure.	Check pump and motor for proper operation.
Pump noisy.	Pump cavitating, water supply line pressure too low.	Check feed water pressure and supply. Inlet pressure should be 20-50 psig with adequate flow.
	Pump and motor misaligned or piping to pump resonating sheet metal adjacent cabinet.	Check pump and motor alignment. Check piping and panels for resonance. Check flow restrictor on outlet side of pump.
	Foreign material in pump.	Check strainer and piping for any obstructions or blockage.
Sight glass empty. Boiler functioning normally.	Sight glass valves closed.	Check sight glass valves and open if necessary.
	Sight glass nozzles and valves plugged with deposits.	Disassemble and clean all sight glass and side arm piping.
Sight glass etched, short life.	High alkalinity (pH 10+) in boiler.	Provide for daily boiler blowdown or increase frequency of drain and flush cycle to reduce contamination in boiler water.

(continued)

TABLE 5-4.
TROUBLESHOOTING CHART - CHS AND CES SERIES (CONTINUED)

PROBLEM	CAUSE	ACTION TO TAKE
Heater gasket leaks after a short period of operation.	Improper or insufficient bolting.	Check bolting. Bolts must be tightened evenly. Do not exceed 200 inch-pounds of torque.
Upper elements have short life.	Boiler feed water or feed water controls not functioning properly.	Check boiler feed water and level controls. Check for excessive foaming and priming which can expose upper elements. Maintain boiler water quality with proper blowdown and drain and flush cycles.
Lower elements have short life.	Boiler water contaminated or has high alkalinity, attacking and corroding element sheath (soft water).	Maintain boiler water quality with proper blowdown and drain and flush cycles. Increase frequency of boiler maintenance.
All elements have short life.	Excessive scale build-up on elements (hard water).	Maintain boiler water quality with proper blowdown (hard water). Increase frequency of boiler maintenance. Consider treating or softening the boiler feed water to reduce scaling.
	Low water cutoff faulty.	Check low water level probe for scaling. Clean as required. Check water level control board for proper operation.
No water in sight glass, contactor(s) chattering.	Water feed system inoperative. Contactor(s) cycling on low water cutoff.	Check feed system. Check water pressure and flow. Check probe rod and wiring. Probe may be shorted to the isolator tube inside the boiler.
Steam pressure fluctuates dramatically under load.	Restrictor in steam line too small.	Check restrictor size.
	Boiler too small for load.	Check steam load and verify capacity requirements.

TABLE 5-5.
LB AND LBAS VOLTAGE AND CURRENT DATA FOR SINGLE-PHASE HEATING ELEMENTS (NON-SOLID STATE, FOUR-DIGIT SERIAL NUMBERED UNITS)

HEATING ELEMENT WATTAGE (KW)	VOLTAGE ACROSS HEATING ROD(S)	MAIN FEEDER LINE CURRENT (Amp)
20	208 ± 5%	96
15	208 ± 5%	72
10	208 ± 5%	48
7.5	208 ± 5%	36
20	230 ± 5%	87
15	230 ± 5%	65
10	230 ± 5%	44
7. 5	230 ± 5%	33
20	440 ± 5%	45
15	440 ± 5%	34
10	440 ± 5%	23
7. 5	440 ± 5%	17

TABLE 5-6.
LB AND LBAS VOLTAGE AND CURRENT DATA FOR SINGLE-PHASE HEATING ELEMENTS (NON-SOLID STATE, FIVE-DIGIT SERIAL NUMBERED UNITS)

HEATING ELEMENT WATTAGE (KW)	VOLTAGE ACROSS HEATING ROD(S)	MAIN FEEDER LINE CURRENT (Amp)
30	208 ± 5%	144
25	208 ± 5%	120
30	230 ± 5%	130
25	230 ± 5%	109
30	440 ± 5%	68
25	440 ± 5%	57

TABLE 5-7.
LB AND LBAS VOLTAGE AND CURRENT DATA FOR THREE-PHASE HEATING ELEMENTS (NON-SOLID STATE, FOUR-DIGIT SERIAL NUMBERED UNITS)

HEATING ELEMENT WATTAGE (KW)	VOLTAGE ACROSS HEATING ROD(S)	MAIN FEEDER LINE CURRENT (Amp)
20	208 ± 5%	55
15	208 ± 5%	42
10	208 ± 5%	28
7.5	208 ± 5%	21
20	230 ± 5%	50
15	230 ± 5%	38
10	230 ± 5%	25
7. 5	230 ± 5%	19
20	440 ± 5%	26
15	440 ± 5%	20
10	440 ± 5%	13
7. 5	440 ± 5%	10

TABLE 5-8.
LB AND LBAS VOLTAGE AND CURRENT DATA FOR THREE-PHASE HEATING ELEMENTS (NON-SOLID STATE, FIVE-DIGIT SERIAL NUMBERED UNITS)

HEATING ELEMENT WATTAGE (KW)	VOLTAGE ACROSS HEATING ROD(S)	MAIN FEEDER LINE CURRENT (Amp)
30	208 ± 5%	83
25	208 ± 5%	69
30	230 ± 5%	75
25	230 ± 5%	63
30	440 ± 5%	39
25	440 ± 5%	33

TABLE 5-9.
LBAS VOLTAGE AND CURRENT DATA FOR THREE-PHASE HEATING ELEMENTS

HEATING ELEMENT WATTAGE (KW)	VOLTAGE ACROSS HEATING ROD(S)	MAIN FEEDER LINE CURRENT (Amp)
4.9 (6.5@230V)	208 ± 5%	14
7.3 (9.75@230V)	208 ± 5%	20
6.5	230 ± 5%	16
9.75	230 ± 5%	25
6.5	440 ± 5%	9
9.75	440 ± 5%	13

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Section 6 – Repair and Replacement

6.0 GENERAL

Many of the procedures described in this section require special skills and should be performed only by qualified persons. Replacement parts are listed in the illustrated parts breakdown (Section 7).

WARNING–ELECTRIC SHOCK AND BURN HAZARD: Voltages and steam pressures normally encountered in the steam generator are potentially dangerous. Always take the following precautions: (1) Allow the steam pressure to drop to zero and the unit to cool. (2) Completely disconnect the unit from the power source before beginning any repair or replacement of components.

6.1 WATER-LEVEL CONTROL, MCDONNELL AND MILLER 150

(LB Series and LBAS Series Non-solid State)

Repair to the water-level control is limited to replacement of the mercury switches, head assembly, or the entire unit.

1. Allow the unit to cool completely and disconnect electrical power from the generator.
2. Remove the covers and loosen screws.

CAUTION – POSSIBLE EQUIPMENT DAMAGE: Do not alter the setting of the four adjustment screws shown in Figure 6-1. The setting of these screws is critical, since improper adjustment could damage the generator. Normally the screws will not require readjustment if the original factory setting is not disturbed.

3. Remove the mercury switch leads from the terminal strip and slide the old switches from the mounting brackets.
4. Connect the leads of the new mercury switches to the terminals indicated in Figure 6-1.
5. Loop the switch leads under the switches so that they lie in the bottom of the switch bracket and allow free movement of the switches. Slide the switches all the way into the slot on the switch brackets. Tighten screws to secure the switches to the bracket.

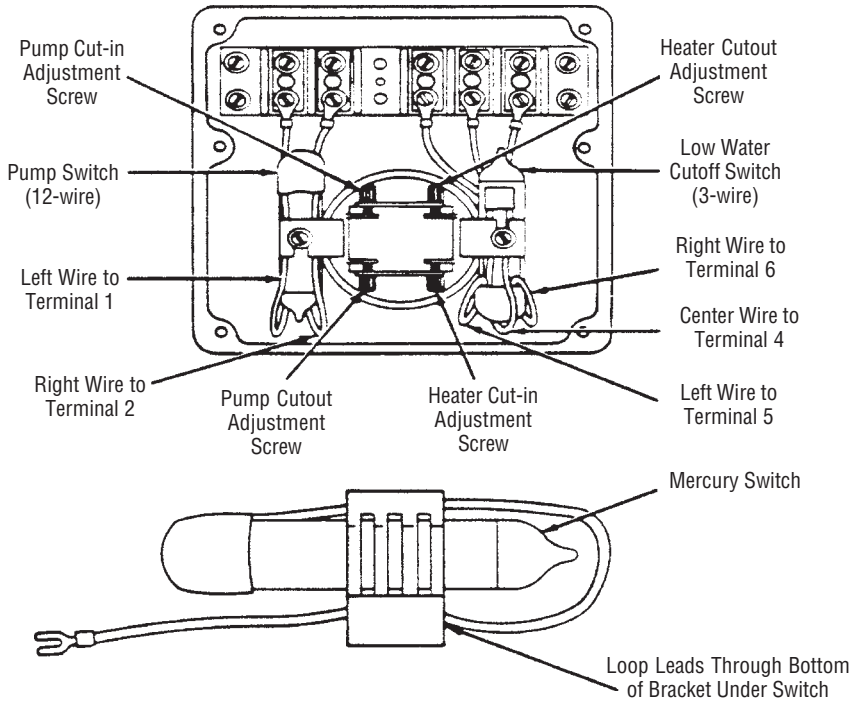

Pump Cut-in Adjustment Screw
Heater Cutout Adjustment Screw
Pump Switch (12-wire)
Low Water Cutoff Switch (3-wire)
Right Wire to Terminal 6
Left Wire to Terminal 1
Center Wire to Terminal 4
Right Wire to Terminal 2
Pump Cutout Adjustment Screw
Heater Cut-in Adjustment Screw
Left Wire to Terminal 5
Mercury Switch
Loop Leads Through Bottom of Bracket Under Switch

Figure 6-1. McDonnell and Miller Water-level Control, Mercury Switch Replacement

6. Reconnect electrical power to the generator and operate the generator through several drain and fill cycles. The pump and low-water cutoff switches should operate at the water levels indicated in Figure 6-2.
   - If switching does not occur at the proper water levels, disconnect power from the generator and check to see if any of the leads from the mercury switches are preventing freedom of movement of the switches.
   - Also check to see that the switches are mounted all the way into the switch brackets.

CAUTION – POSSIBLE EQUIPMENT DAMAGE: Do not attempt to correct improper switching by rotating the adjustment screws until absolutely sure that lead position and switch mounting are correct. If readjustment is necessary, rotate the applicable adjustment screw in the direction required, as indicated in Table 6-1, and check for proper switching. Alternately adjust and check unit switching at the levels shown in Figure 6-2.

7. After proper switching is obtained, disconnect electrical power from the generator and replace the covers on the water-level control.

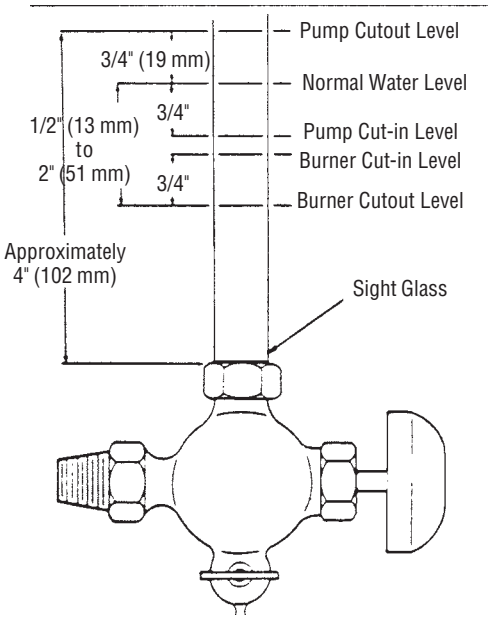


Figure 6-2.
Water-level Control Switching Points for McDonnell and Miller Water-level Control

Table 6-1. Adjustment Data for McDonnell and Miller Water-level Control

NOTE: See cautions in text before using table.		
	Direction to Turn Screw for Switching at:	
Adjustment Screw	**Higher Water Level**	**Lower Water Level**
Pump Cutout	CCW	CW
Pump Cut-in	CW	CCW
Burner Cut-in	CCW	CW
Burner Cutout	CW	CCW

6.2 WARRICK WATER-LEVEL CONTROL, (LB/LBAS SERIES NON-SOLID STATE)

6.2.1 General

Warrick Water-Level Control consists of two liquid level control relays, three (A, B, and C) liquid level sensing rods, and a cast enclosure. Table 6-2 gives the lengths of the liquid level sensing rods for the various LB Series and LBAS Series Non-solid State generator models.

Water is admitted into tank until the A rod is submerged. Continuity between the A rod and ground (via the water) causes the generator main power coil to pick up applying power to the remaining controls. The pump motor starts and water is pumped into the tank until the C rod is submerged. Water is used from the tank until the B rod is no longer submerged. Then the pump restarts and the cycle repeats.

Rods come in sets of three or four and are stainless steel. They are 14" (356 mm) long and must be cut to lengths specified in Table 6-2.

Table 6-2. Length Of Rods For Warrick Water-Level Control (Non-solid State)

Generator Models	Rod A*	Rod B*	Rod C*
LB15AS & LB20AS	8"	7"	5-1/2"
LB10 thru LB30	10-3/4"	9-1/4"	8-1/4"
LB 40 thru LB60	14"	13-1/2"	12-3/4"
LB80 thru LB120 built before l/74	14"	13"	12"
LB80 thru LB120 built after 1/74	6"	5"	4"
LB1 50 thru LB1 80	6"	5"	4"
**See Figure 7-9*			

NOTES: 1) For solid state LBAS series see Figure 7-3 and 7-4. 2) If rod length (as specified in Table 6-2) is other than that shown, the generator control will cycle ON and OFF rapidly. This cycling will cause premature failure of the generator level control relays.

6.2.2 Complete Electric Relay Assembly Replacement

1. Tag and disconnect electrical leads from relay box to control head, water-inlet solenoid, and electrical panel box.
2. Remove relay assembly box and replace with new unit. Reconnect tagged disconnected leads to their numbered positions on the two TG relays.
3. Operate the generator through several flush- and-fill cycles. If proper water level or cutoff action is not obtained, check to make certain that connections have been made to the properly numbered locations. These are clearly shown in the wiring diagrams.

6.2.3 TG Relay Replacement

1. Tag and loosen connecting wires.
2. Remove relay by loosening four hold-down screws.
3. Replace with new relay and reconnect wires to correct locations which are numbered for convenience.

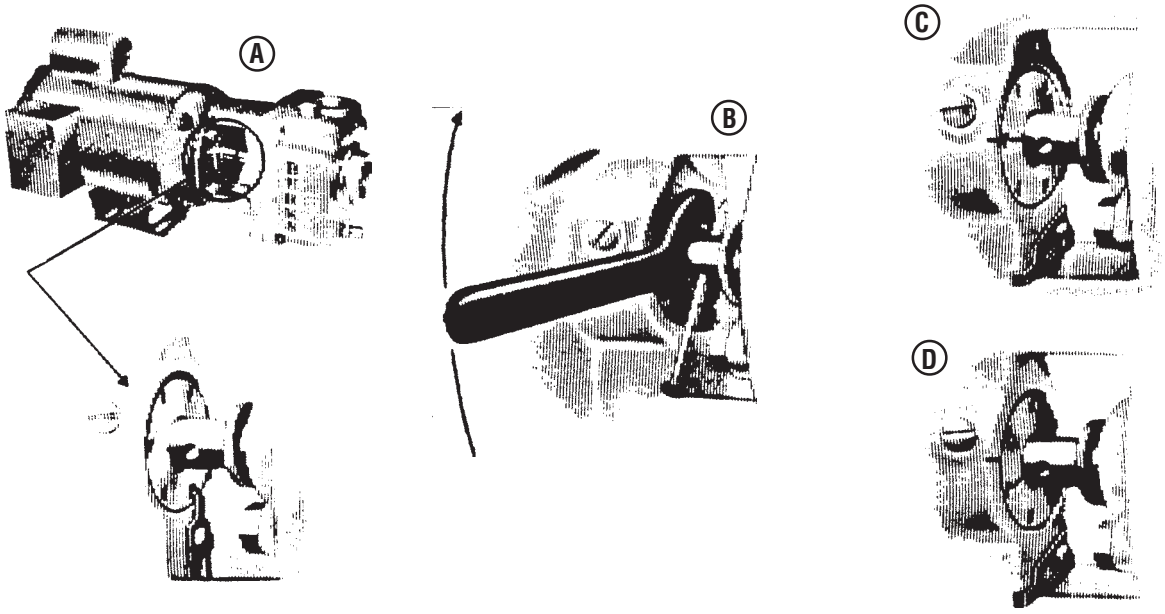


Figure 6-3. Motor and Pump Impellers and Raceways Adjustment

6.3 WATER-LEVEL CONTROL LBAS SERIES SOLID STATE UNITS

General – Water-Level Control consists of a liquid level control printed circuit board and four (A, B, C, and D) liquid level sensing rods. See Figure 7-3 and 7-4 for the lengths of the liquid level sensing rods.

Water is admitted into tank until the A rod is submerged. Continuity between the A rod and ground (via the water) causes the generator main power coil to pick up applying power to the remaining controls. Water is pumped into the tank until the C rod is submerged. Water is used from the tank until the B rod is no longer submerged. Then the pump restarts and the cycle repeats.

Rods come in sets of four and are stainless steel. They are 14" (356 mm) long and must be cut to lengths specified in Figure 7-3 and 7-4. Order P-764316-748 for four stainless-steel rods. The electrodes can be removed as described in the water-level control cleaning procedures (paragraph 4.6).

NOTE: If rod length as specified in Figure 7-3 and 7-4, are other than that shown, it will cause the generator control to cycle the water pump ON/OFF rapidly, causing premature failure of the generator CR1 relay.

6.4 PRINTED CIRCUIT BOARD REPLACEMENT LBAS SOLID STATE UNITS

1. Tag and loosen connecting wires.
2. Remove printed circuit board.
3. On generators with serial numbers 27871 and lower, order and install PC board replacement kit (P-764322-032) and reconnect wires to circuit board as indicated on instruction sheet supplied with kit.
4. On generators with serial numbers 27872 and higher, replace with new PC board (P-755715-735) and reconnect wires to circuit board as tagged in step 1 above.

6.5 PRESSURE SWITCH ADJUSTMENT

1. **Honeywell Series**

   The pressure switch is normally set at the factory for 75 psig. If the pressure setting must be changed, turn the adjusting screw (located on top of the controller) until the pressure setting indicator on the front of the controller is at the desired control pressure set point.

   NOTE: Pressure switch should be set to a maximum of 10 psig below the generator safety valve pressure rating.

2. **Barksdale Series**

   The **left** switch is normally set at the factory for 75 psig. (This switch is used as the generator pressure control.) The **right** switch is normally set at the factory for approximately 10 psig below the generator safety valve. (This switch is used as a "fail-safe" in the event the **left** switch malfunctions.) If the pressure settings must be changed, rotate the thumbwheel clockwise to raise the pressure or counterclockwise to lower the pressure, using the generator pressure gauge as an indicator.

3. **CES and CHS series**

   General – Boilers are supplied with both an operating pressure control (Figure 6-4) and a high-limit pressure control (Figure 6-5). The operating pressure control is used for controlling the operating pressure of the boiler. Boilers 100 kW and larger have two operating pressure controls. The high-limit pressure control (only one on all units) is used to limit the pressure in the boiler. To determine the difference in the controls, the high-limit has a manual reset lever on top of the case. Also, the high-limit has no differential scale present.

On all controls, the pressure adjusting screw on the top of the case sets the desired operating pressure. Turning the screw counterclockwise reduces the pressure setting (**cut out**). The high-limit control should be set at 10 psig above the operating pressure of the boiler, 90 psig maximum.

The differential adjusting screw on the operating pressure control is set in the same manner as the pressure adjusting screw. The **cut out** setting minus the differential setting equals **cut in** pressure of the operating pressure control.

2. **Operating Pressure Control:**

a. To check operation of the operating pressure, first verify the setting on the control. The setting should be 80 psig. The differential setting should be set at 10 psig. Note that boilers rated 100 kW and larger have two operating pressure controls; set both at the same pressure.

b. Turn the boiler ON and allow it to heat up while observing the pressure gauge.The heater contactor(s) should be energized until the pressure reaches the operating pressure control set point. At that point, the contactor(s) drop out. The contactor(s) should remain off until the pressure in the boiler has dropped to the differential setting.

c. To reset the pressure control, bleed off pressure from the boiler by opening the steam outlet, drain, or blowdown valve. If the pressure gauge indicates operation outside the range, adjust as necessary.

3. **High-limit Pressure Control**

a. The high-limit control is to be set at 90 psig maximum. The high limit is tested in the same manner as the operating pressure control, except with the operating pressure control set above the setting of the high-limit control.

CAUTION: Reset both controls to their proper settings after testing is complete.

b. Adjust the high limit control to 20 psig. Adjust the operating pressure control to 25 psig.

c. Turn the boiler ON. The boiler heats up and builds pressure until the setting of the high-limit control is reached. At this point, the contactor(s) drop out. Allow pressure to drop in the boiler.

d. The heater contactor(s) should remain de-energized even when the pressure drops below the high-limit control setting. When the pressure drops below the high-limit pressure setting, the manual reset lever must be pushed to resume operation. Push the reset lever on the high-limit control and the contactor(s) should re-energize.

e. After confirming this action, turn the boiler OFF and reset both the operating pressure control and the high-limit control. The operating control should be set to 80 psig and the high-limit control should be set to 90 psig.

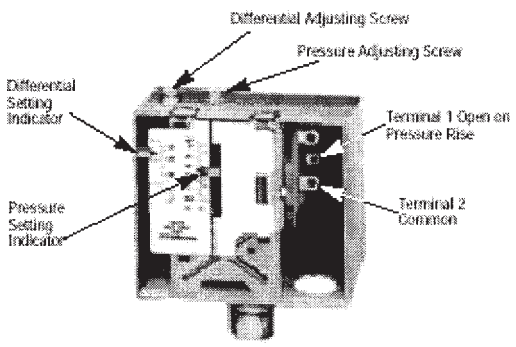


Figure 6-4. Operating Pressure Control

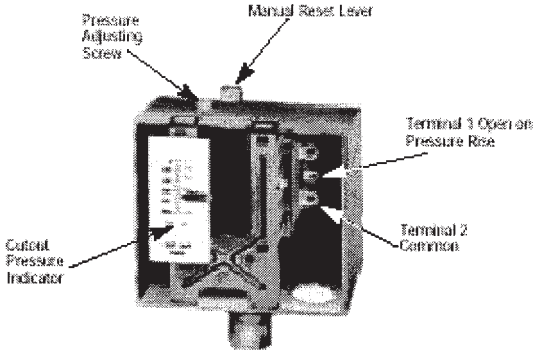


Figure 6-5. High-limit Pressure Control

6.6 WATER PUMP AND MOTOR

1. Repair of the water pump normally is limited to replacement of the pump shaft seal and impeller. When other trouble develops, the water pump and/or pump motor can be replaced as separate items, or both the pump and motor can be replaced as a complete unit (see Figures 7-1 and 7-2). When replacing only the motor, it is necessary to disassemble the water pump to remove the impeller from the motor shaft. (On earlier units with gear pumps, the motor can be separated from the water pump at the coupling.)

2. A condition may exist, even on new pumps, where there is excessive clearance between impeller and raceway on motor and pump assembly resulting in insufficient pressure output. Either adjust or replace impeller and raceway. To adjust impeller for correct relationship with raceway:

   a. Turn OFF power to pump.

   b. Loosen slide lock on impeller adjusting screw (Figure 6-3, A).

   c. Slide a nail through hole provided on motor shaft and position special spanner wrench (P-764315-272) on adjusting screw (Figure 6-3, B).

NOTE: To avoid damaging pump, do not use any tool other than the special spanner wrench to turn adjusting screw.

   d. Simultaneously, advance spanner wrench and nail clockwise, as viewed facing the motor, until a drag is detected. This drag indicates that impeller is in contact with raceway.

NOTE: A spring, located behind bearing in motor, forces shaft, bearing and impeller toward raceway when adjusting screw is advanced. In older pumps, corrosion may prevent movement of bearing when adjusting screw is advanced. If this happens:

   1) Remove end cap from pump.

   2) Tap motor shaft lightly to loosen bearing so that bearing can move forward. Movement is slight and cannot be readily observed. However, drag on spanner wrench will be detected when bearing breaks loose.

3) Replace end cap.

   e. See Figure 6-3, C and mark pump frame and adjusting screw across one of the punched holes in adjusting screw.

   f. Turn spanner wrench and nail counterclockwise, as viewed when facing motor, one-half the distance between marked hole and next hole in adjusting screw. (Refer to Figure 6-3, D.) This should provide proper clearance (under working pressure) between the impeller and the raceway.

   g. Replace slide lock on impeller adjusting screw.

   h. Turn ON power to pump motor.

   i. Drain sufficient water from generator reservoir to actuate pump motor.

   j. Observe pump as water pressure increases. If pump labors, impeller and raceway must be contacting. Additional clearance is needed to correct this. To gain more clearance:

1) Repeat steps a, b, and c. Next, simultaneously turn spanner wrench and nail counterclockwise, as viewed when facing motor. Only a slight additional turn is required. See NOTE above.

NOTE: When adjusting clearance, it is better to have more clearance than not enough. If the impeller and raceway are allowed to make contact while in service, the sealing grooves will burn and damage pump.

2) Again, replace slide lock on impeller adjusting screw and turn ON power to pump.

3. When installing new impellers and race ways, it is important that:

   - Impeller be in alignment with gasket face and pump frame so that there is no weave as impeller rotates.
   - Impeller be back in frame far enough so that raceway does not contact impellers.
   - Gasket surface be clean and raceway must fit tightly against frame.

6.7 WATER-LEVEL SIGHT GLASS REPLACEMENT (SEE FIGURE 7-11)

6.7.1 Replacing Water-Level Sight Glass

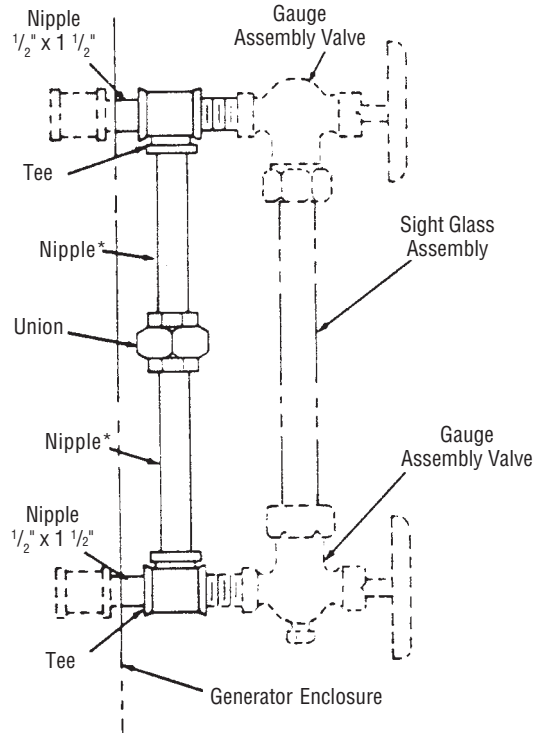
1. Remove the sight glass guards.
2. Loosen the glass pipe retaining collars on the top and bottom valves.
3. Carefully remove broken glass from the openings of the valves and clean the openings thoroughly.
4. Place retaining collar on the new glass pipe and then slide metal washer over the ends of the pipe.
5. Slip new rubber seals over each end of the pipe and position about 1" (25 mm) from each end.
6. Gently insert one end of the glass into the top gauge fitting, then insert glass into bottom fitting until glass bottoms out inside the bottom fitting.
7. Carefully raise glass about 1/16" and slide lower sight glass seal down until the glass packing contacts the lower gauge fitting. DO NOT allow the glass to remain in contact with any metal.
8. Carefully slide upper sight glass seal up as far as possible.
9. Hand tighten both glass packing nuts, then tighten 1/2 turn more by wrench. Tighten only enough to prevent leakage. DO NOT OVER TIGHTEN. If any leakage should occur, tighten slightly, a quater turn at a time, checking for leakage after every turn.

NOTE: Also refer to sight glass replacement procedure furnished with sight glass kits.

6.7.2 Shunting Water-level Sight Glass

Electrolytic action may cause short life of the sight glass. To solve this problem, install kit P-757970-091 as follows:

1. Disassemble the sight glass assembly per instructions in paragraph 6.7.1
2. Install the shunt arrangement between the generator and the gauge assembly valve as shown in Figure 6-6.
3. Replace the sight glass per instructions in paragraph 6.7.1



**Length as required*

Figure 6-6.
Sight Glass Assembly with Shunt Assembly.

6.8 HEATING ELEMENT REPLACEMENT

WARNING – ELECTRIC SHOCK AND BURN HAZARD: Disconnect electrical power at source before servicing generator to avoid personal injury or death.

WARNING – SEVERE PERSONAL INJURY AND BURN HAZARD: Allow boiler to cool and pressure to drop to zero before servicing.

CAUTION – POSSIBLE EQUIPMENT DAMAGE: Provision should be made to prevent water damage from any eventual leaking of boiler or components. Install near a floor drain.

1. Before proceeding with heating element replacement, review causes of element failure to determine if items other than element replacement need to be serviced.
2. Check that boiler is properly drained. Note wire locations, disconnect wires, and remove failed heating element from the boiler.
3. Examine condition of other elements in the boiler. If a heavy solids build-up is evident or elements show any warping or distortion, replace all affected elements.
4. Examine heater element bolts. If these are corroded, replace with ASME grade B-7 bolt of equivalent size.
5. Clean the flange face on boiler carefully so as to maintain smooth gasket surface.
6. Install gasket over heater element and insert element into boiler. When installing heating element gasket do not use any liquid sealer, etc. Install dry.

WARNING – ELECTRIC SHOCK AND BURN HAZARD: Torquing to specifications should be done when unit is cold and with power disconnected at source.

7. Figure 6-7 illustrates bolt tightening sequence required when replacing heating elements. Tighten all bolts finger tight, then sequentially torque bolts in two stages. First to 100 in/lb (8.3 ft/lb) then to a final torque of 200 in/lb (16.6 ft/lb).
8. Reconnect wiring to heater element and follow boiler start up procedures. Check that required electrical clearance between terminals is maintained.

NOTE: Heater element bolts should be retorqued to specifications after generator has been operating several hours at working pressure.

WARNING – ELECTRIC SHOCK AND BURN HAZARD: Torquing to specifications should be done when unit is cold and with power disconnected at source.

6.9 CHECK VALVES

Repair of the check valves is limited to cleaning valve seats when foreign matter is the cause of improper operation. The spring-loaded check valve (Figure 7-1 or Figure 7-2) can be cleaned without removing the valve body from the generator plumbing; however, the flapper check valve (Figure 7-1 or Figure 7-2) must be removed for cleaning. When a valve of either type becomes defective, the entire valve must be replaced.

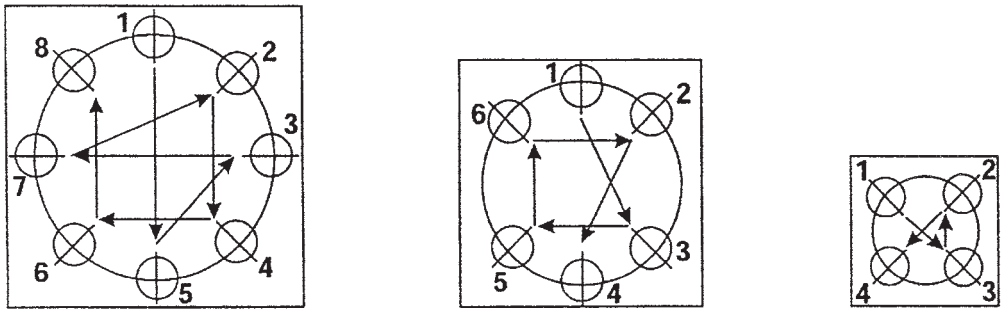
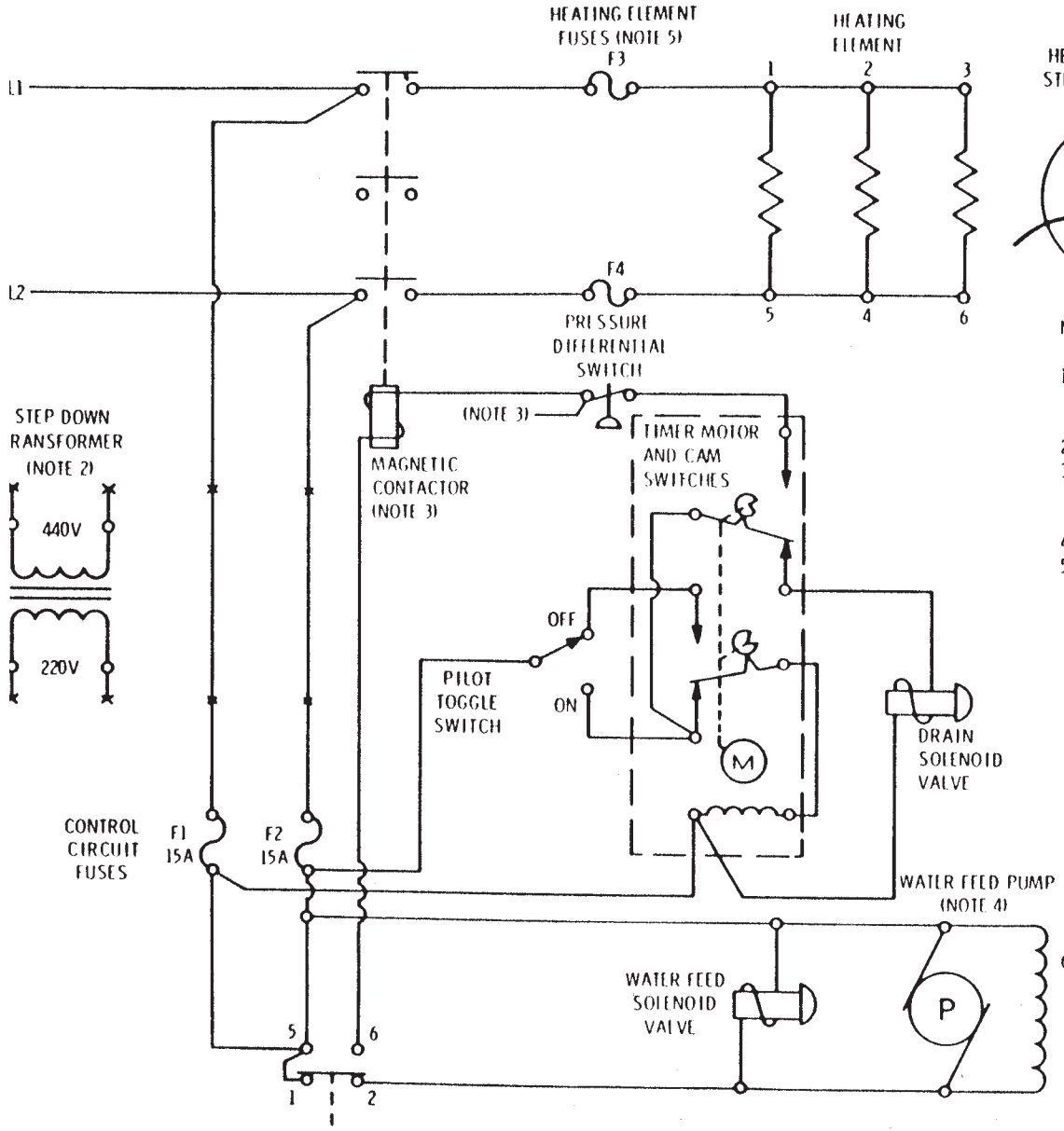
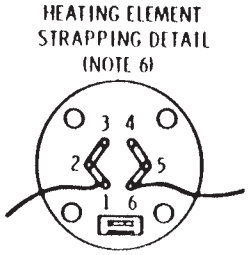


Figure 6-7.
Heater Element Bolt-Tightening Pattern





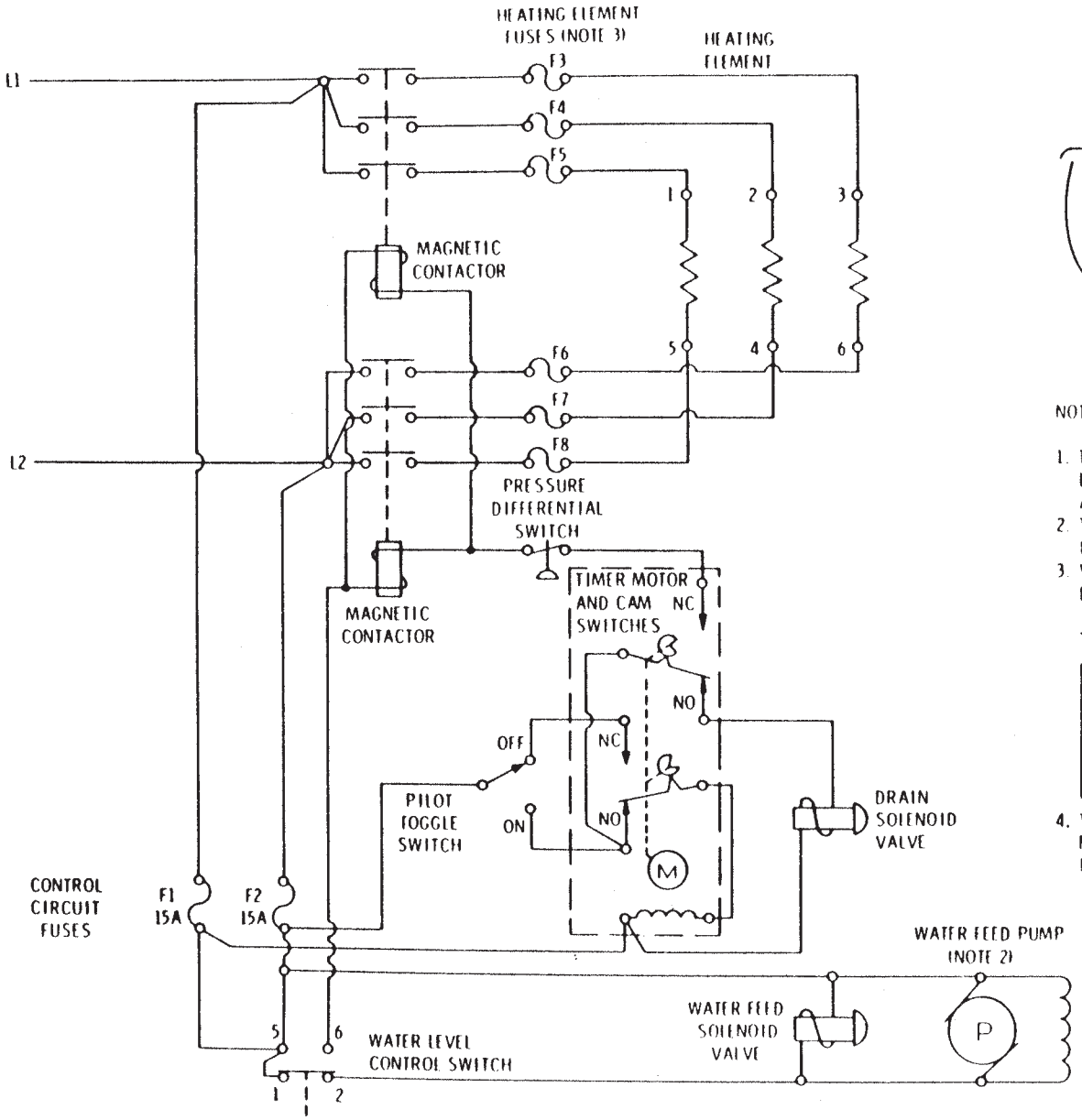
NOTES:

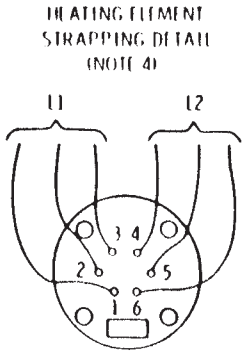
1. THIS DIAGRAM APPLIES TO ALL AUTOMATIC FLUSH MODELS WIRED FOR SINGLE-PHASE OPERATION (EXCEPT LB-15 AND LB-20 SINGLE PHASE, 230 VAC).
2. STEP-DOWN TRANSFORMER IS USED FOR 440V OPERATION ONLY.
3. MODELS WITH MULTIPLE SECTIONS USE A MAGNETIC CONTACTOR, A SET OF TWO FUSES, AND A HEATING ELEMENT FOR EACH SECTION.
4. THE LOW PRESSURE OPTION DOES NOT USE A WATER PUMP.
5. VALUES FOR THE HEATING ELEMENT FUSES DEPEND ON THE TYPE OF HEATING ELEMENT USED IN A PARTICULAR SECTION. THE HEATING ELEMENT TYPE IS STAMPED ON THE NAMEPLATE OF THE ELEMENT. FUSES FOR A SPECIFIC HEATING ELEMENT ARE LOCATED DIRECTLY ABOVE THEIR RESPECTIVE ELEMENT.

	FUSE RATING F3 & F4	HEATING ELEMENT	
		WATTAGE	MODEL
220V OPERATION	50	10 KW	HE103
	40	7.5 KW	HE104
440V OPERATION	50	20 KW	HE101A
	40	15 KW	HE102A
	30	10 KW	HE103A
	30	7.5 KW	HE104A

6. TERMINALS ON HEATING ELEMENTS ARE NOT ACTUALLY NUMBERED. NUMBERS ARE ASSIGNED FOR REFERENCE PURPOSES ONLY.

Figure 6-8. LB Series Steam Generator Schematic Wiring Diagram, Single-Phase with Float-Type Water-Level Control and Automatic Flushing (for units with four-digit serial numbers).





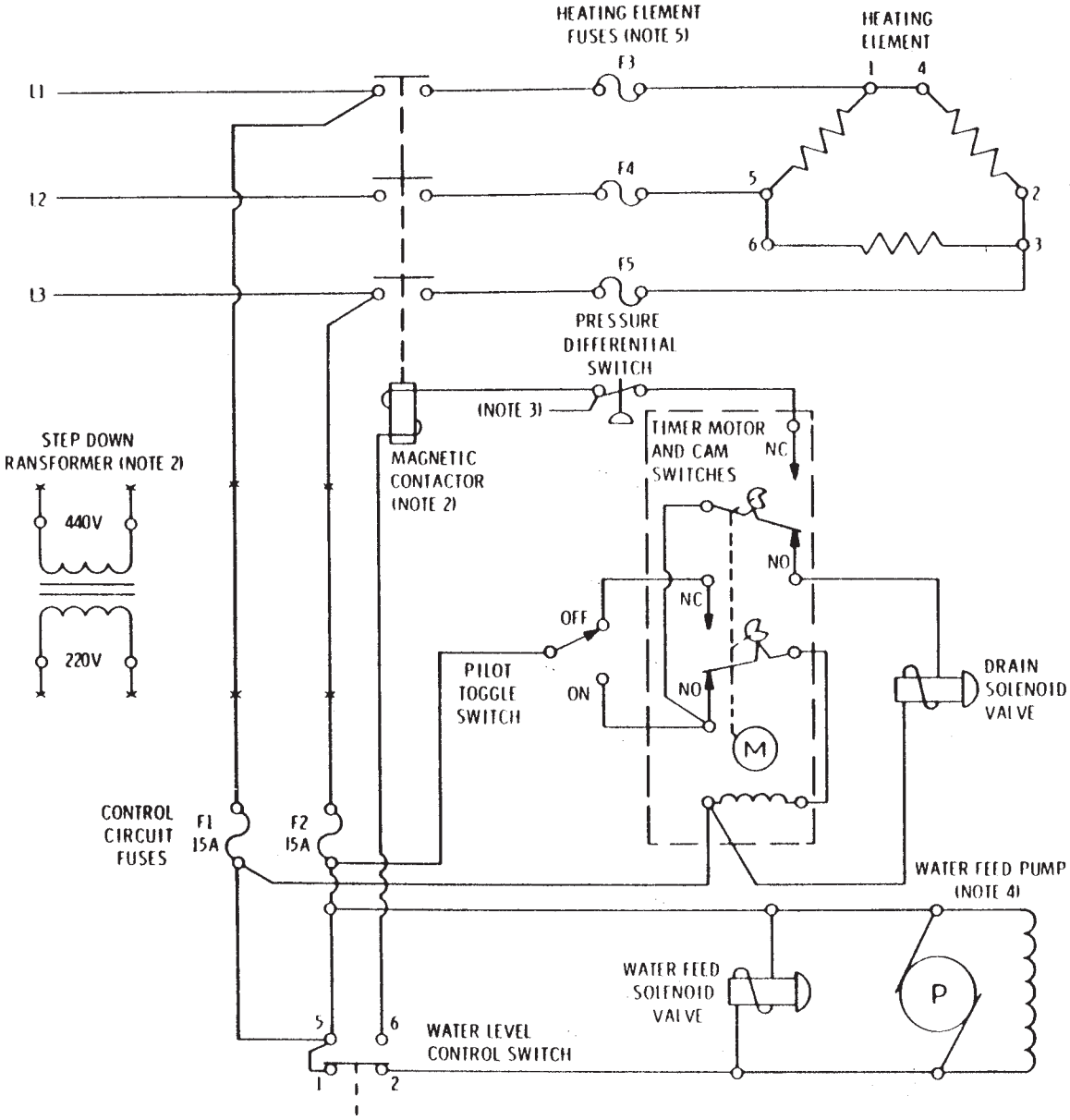
NOTES:

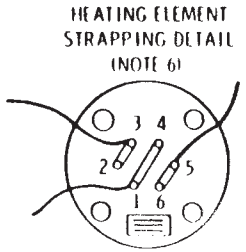
1. THIS DIAGRAM APPLIES TO AUTOMATIC FLUSH MODELS LB-15 AND LB-20 ONLY WHEN OPERATED SINGLE PHASE AT 230 VOLTS.
2. THE LOW PRESSURE OPTION DOES NOT USE A WATER PUMP.
3. VALUES FOR THE HEATING ELEMENT FUSES F3, F4 AND F5 DEPEND ON THE TYPE HEATING ELEMENT USED. THE HEATING ELEMENT TYPE IS STAMPED ON THE NAMEPLATE OF THE ELEMENT.

FUSE RATING F3 THRU F8	HEATING ELEMENT	
	WATTAGE	MODEL
40A	20 KW	HE101
30A	15 KW	HE102

4. TERMINALS ON HEATING ELEMENTS ARE NOT ACTUALLY NUMBERED. NUMBERS ARE ASSIGNED FOR REFERENCE PURPOSES ONLY.

Figure 6-9. LB-15 andLB-20 Steam Generator Schematic Wiring Diagram, Single-Phase 230-Volt with Float-Type Water-Level Control and Automatic Flushing (for units with four-digit serial numbers).





NOTES:

1. THIS DIAGRAM APPLIES TO ALL AUTOMATIC FLUSH MODELS WIRED FOR THREE PHASE OPERATION.
2. THE 440V-TO-200V STEP-DOWN TRANSFORMER IS USED FOR 440V OPERATION ONLY.
3. MODELS WITH MULTIPLE SECTIONS USE A SEPARATE MAGNETIC CONTACTOR, A SET OF THREE FUSES, AND A HEATING ELEMENT FOR EACH SECTION.
4. LOW PRESSURE OPTION DOES NOT USE A WATER PUMP.
5. VALUES FOR THE HEATING ELEMENT FUSES F3, F4 AND F5 DEPEND ON THE TYPE OF HEATING ELEMENT USED IN A SPECIFIC SECTION. THE HEATING ELEMENT TYPE IS STAMPED ON THE NAMEPLATE OF THE ELEMENT. FUSES FOR A SPECIFIC HEATING ELEMENT ARE LOCATED DIRECTLY ABOVE THEIR RESPECTIVE ELEMENT.

		HEATING ELEMENT	
	FUSE RATING	WATTAGE	MODEL
208V OR 220V OPERATION	60A	20 KW	HE101
	50	15 KW	HE102
	30	10 KW	HE103
	30	7.5 KW	HE104
440V OPERATION	30A	20 KW	HE101A
	30	15 KW	HE102A
	30	10 KW	HE103A
	30	7.5 KW	HE104A

6. TERMINALS ON HEATING ELEMENTS ARE NOT ACTUALLY NUMBERED. NUMBERS ARE ASSIGNED FOR REFERENCE PURPOSES ONLY.

Figure 6-10. LB Series Steam Generator Schematic Wiring Diagram, Three-Phase with Float-Type Water-Level Control and Automatic Flushing (for units with four-digit serial numbers).

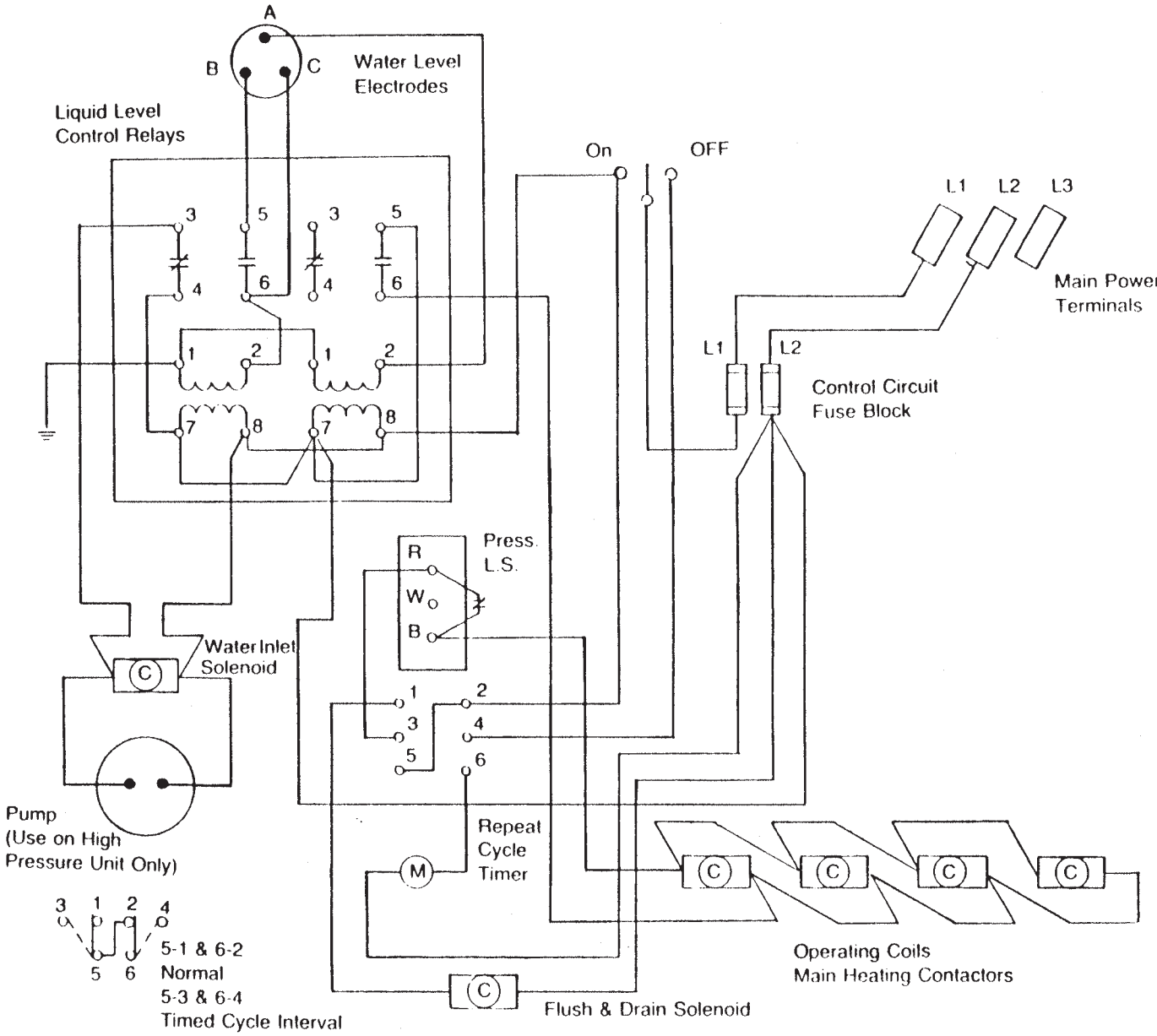


Figure 6-11. Wiring Diagram – LB Series with Electric Water-Level Control and Automatic Flush and Drain; 208-240 Volt Three-Phase, 60 Hz (for units with five-digit serial numbers).

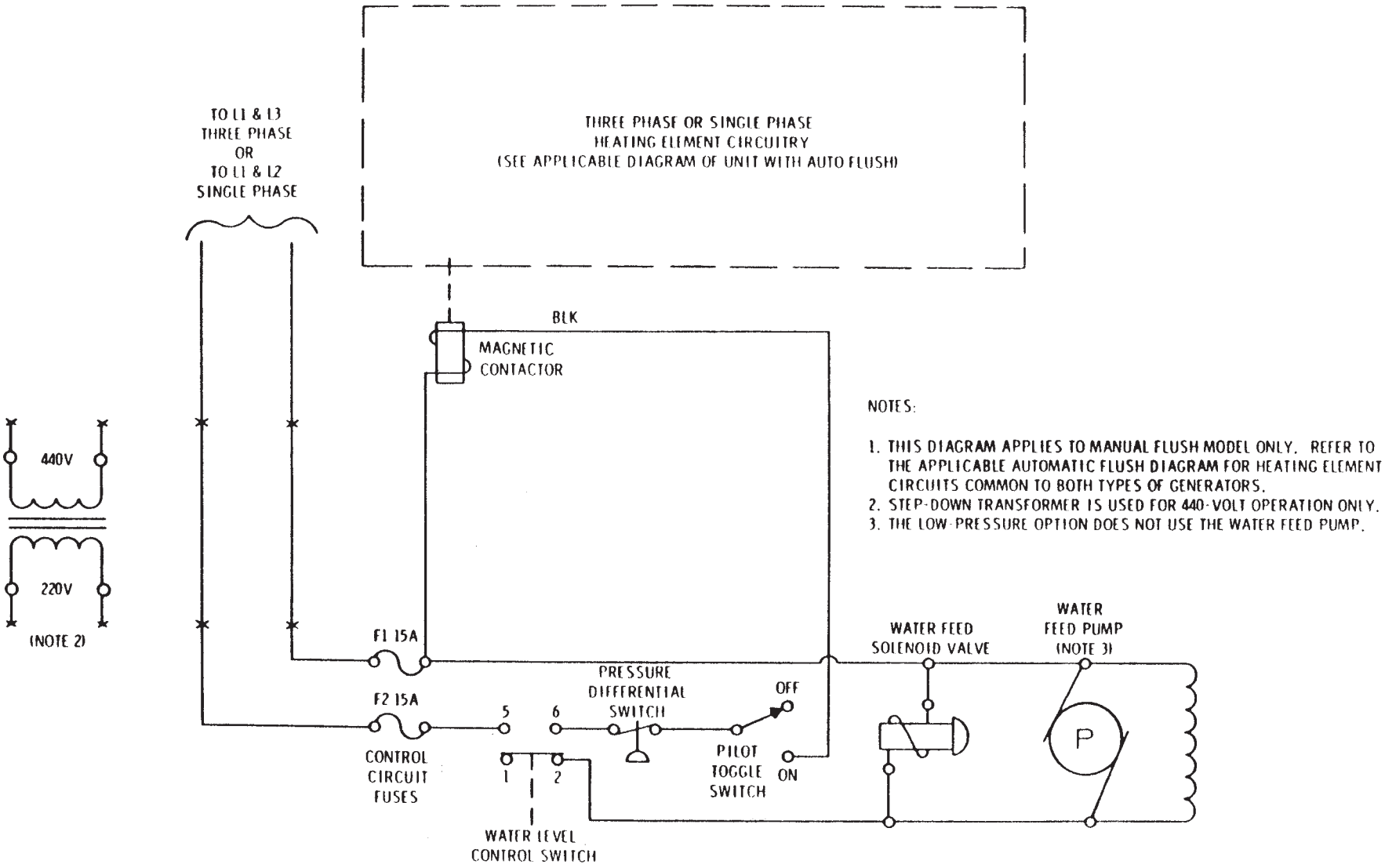
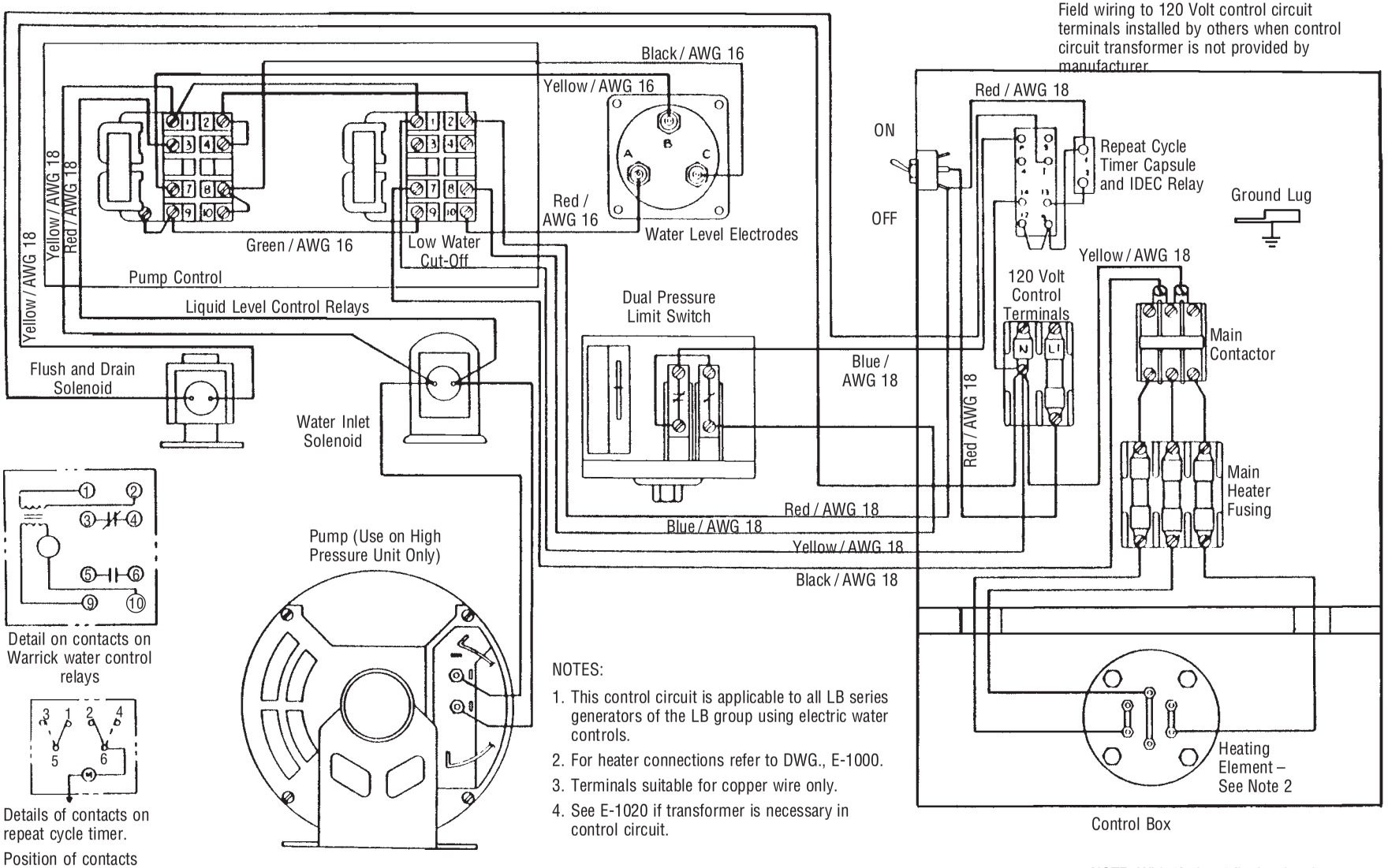


Figure 6-12. LB Series Steam Generator Schematic Wiring Diagram (for units without automatic flushing).


NOTE:
Field wiring to 120 Volt control circuit terminals installed by others when control circuit transformer is not provided by manufacturer.
Black / AWG 16
Yellow / AWG 16
Red / AWG 16
Water Level Electrodes
Green / AWG 16
Low Water Cut-Off
Yellow / AWG 18
Red / AWG 18
Yellow / AWG 18
Pump Control
Liquid Level Control Relays
Flush and Drain Solenoid
Water Inlet Solenoid
Dual Pressure Limit Switch
Blue / AWG 18
Red / AWG 18
Blue / AWG 18
Yellow / AWG 18
Black / AWG 18
ON
OFF
Red / AWG 18
Repeat Cycle Timer Capsule and IDEC Relay
Ground Lug
Yellow / AWG 18
120 Volt Control Terminals
Main Contactor
Main Heater Fusing
Heating Element – See Note 2
Control Box
Pump (Use on High Pressure Unit Only)
NOTES:
1. This control circuit is applicable to all LB series generators of the LB group using electric water controls.
2. For heater connections refer to DWG., E-1000.
3. Terminals suitable for copper wire only.
4. See E-1020 if transformer is necessary in control circuit.
NOTE: With "Artisan" flush relay timer.

Detail on contacts on Warrick water control relays

Details of contacts on repeat cycle timer.

Position of contacts shown is that when unit is started from cold start and sequence is begun by automatic timed flush.

Figure 6-13. Wiring Diagram – LB Series with Electric Water-Level Control and Automatic Flush and Drain Using Artisan Solid-State Flush Relay.

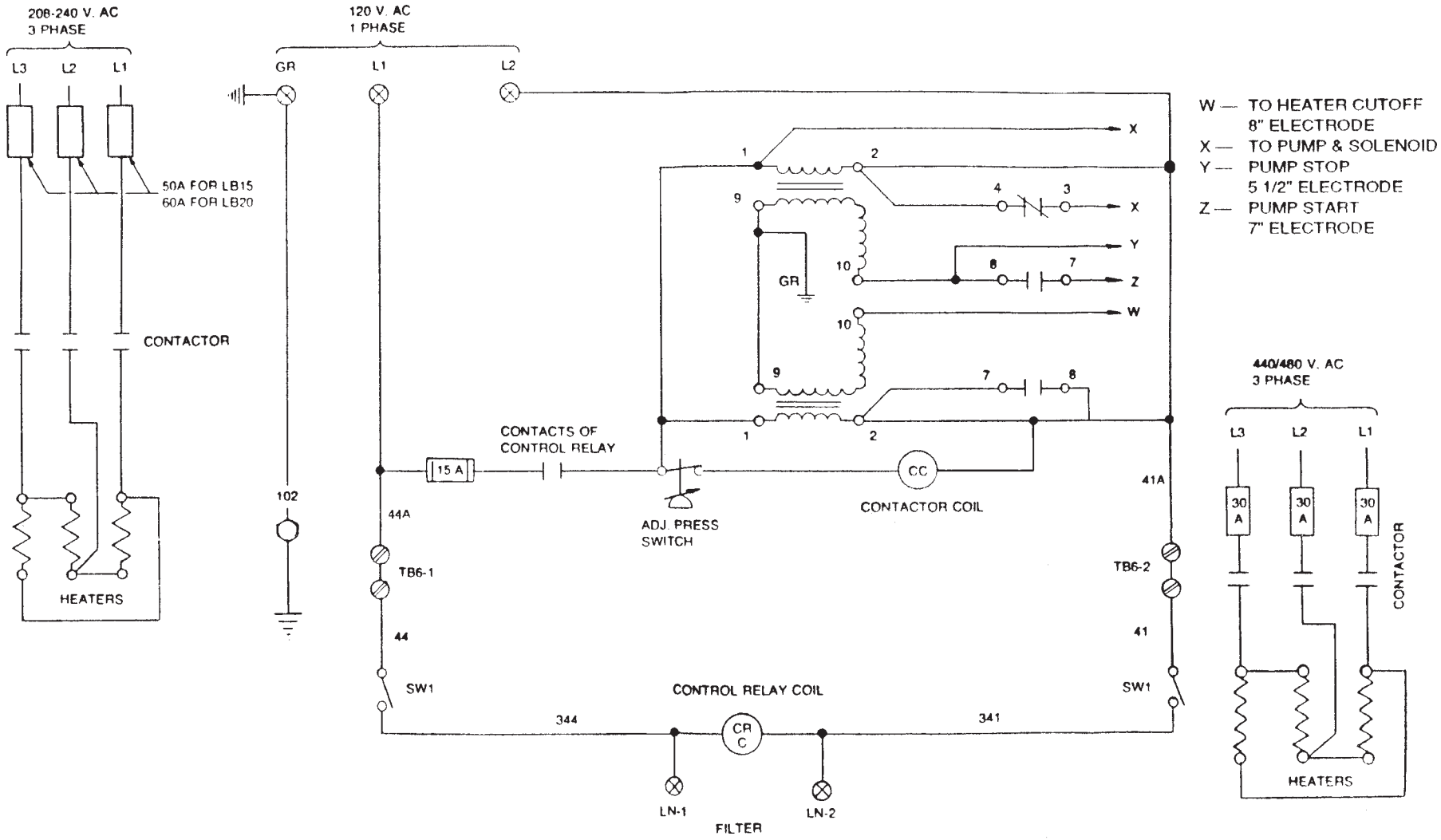


Figure 6-14. LB15AS and LB20AS Steam Generator Electrical Schematic; Three-Phase with Electric Water-Level Control (non-solid state).

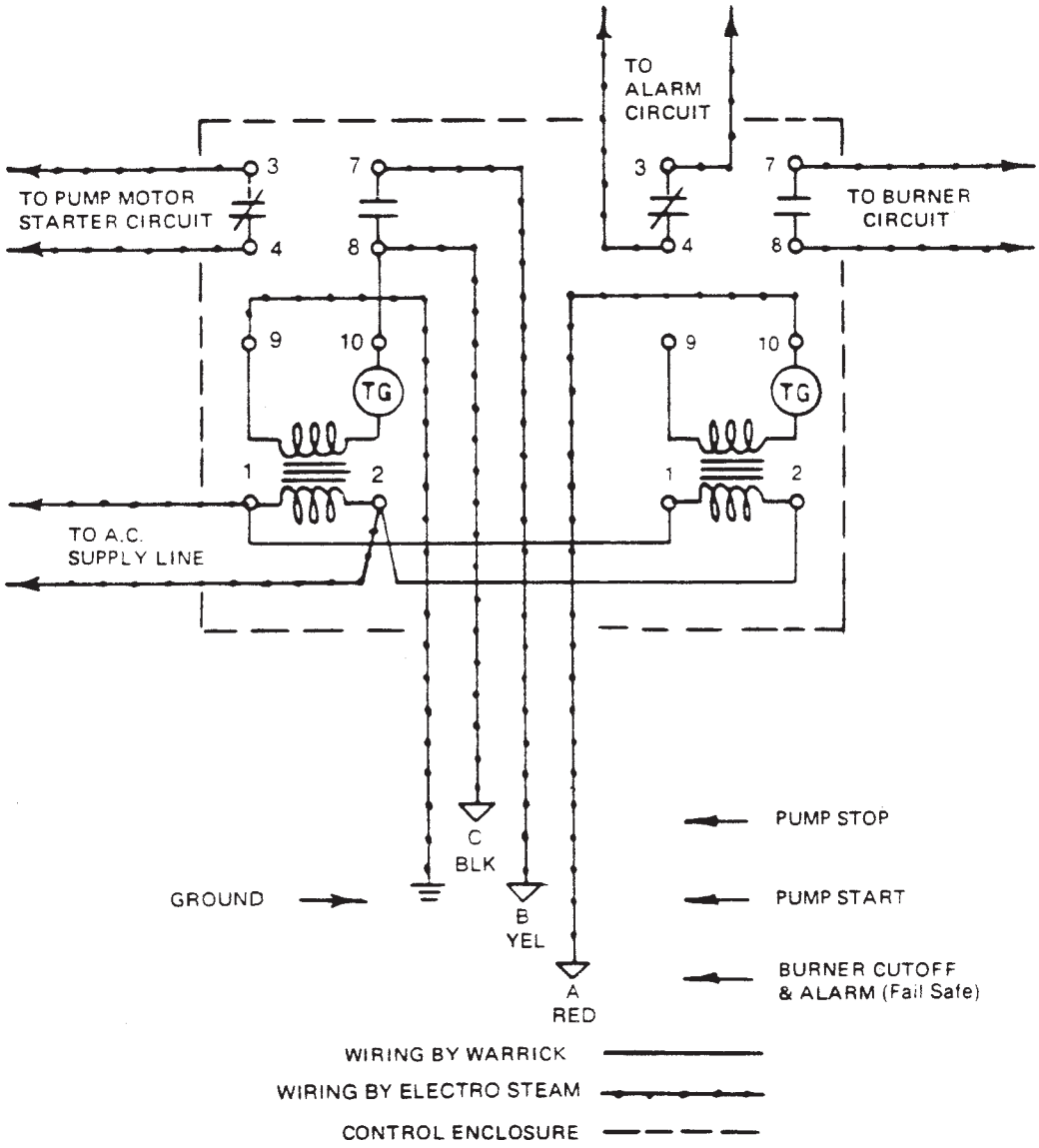


Figure 6-15. Wiring Schematic for Floatless Type Water-Level Control (Non-solid State).

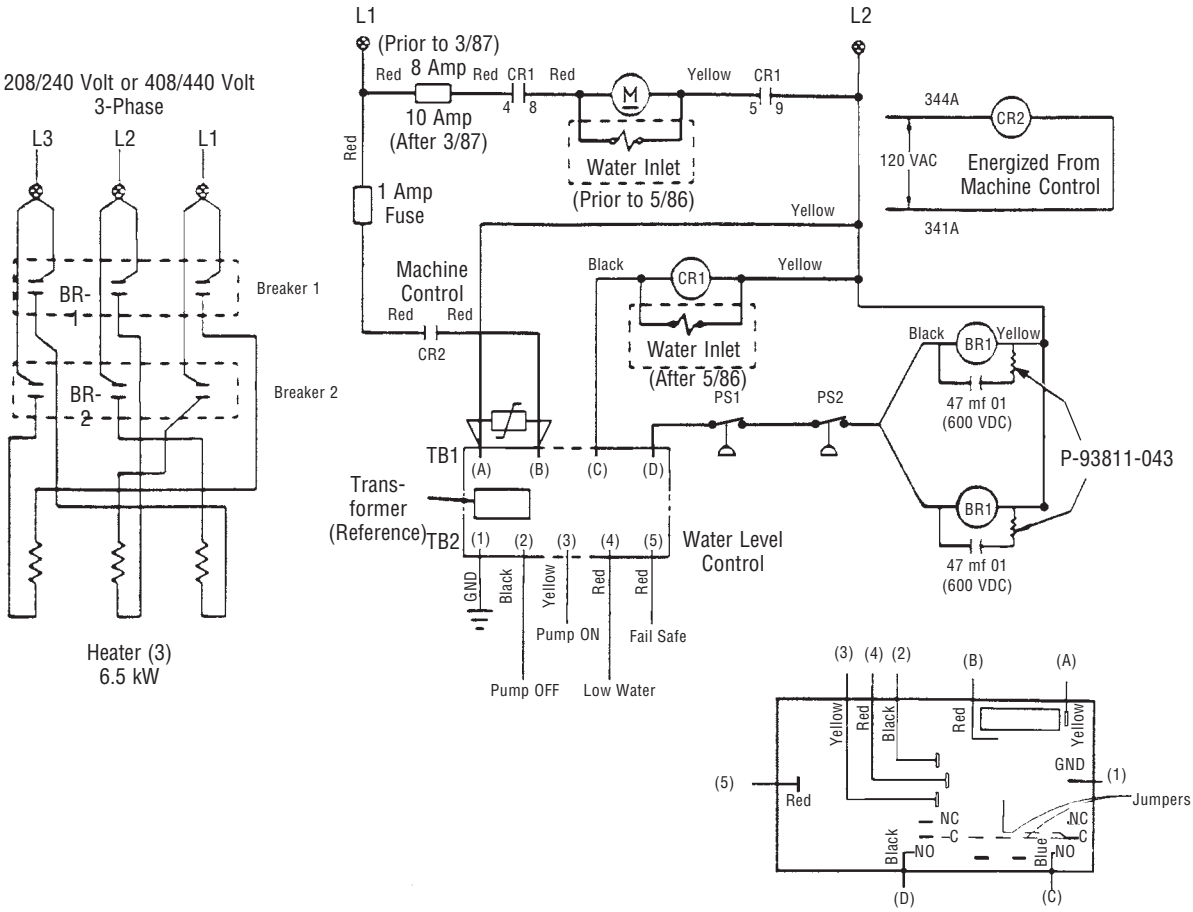


Figure 6-16. LBAS Series Solid State Control – Wiring Diagram (for units with two contactors).

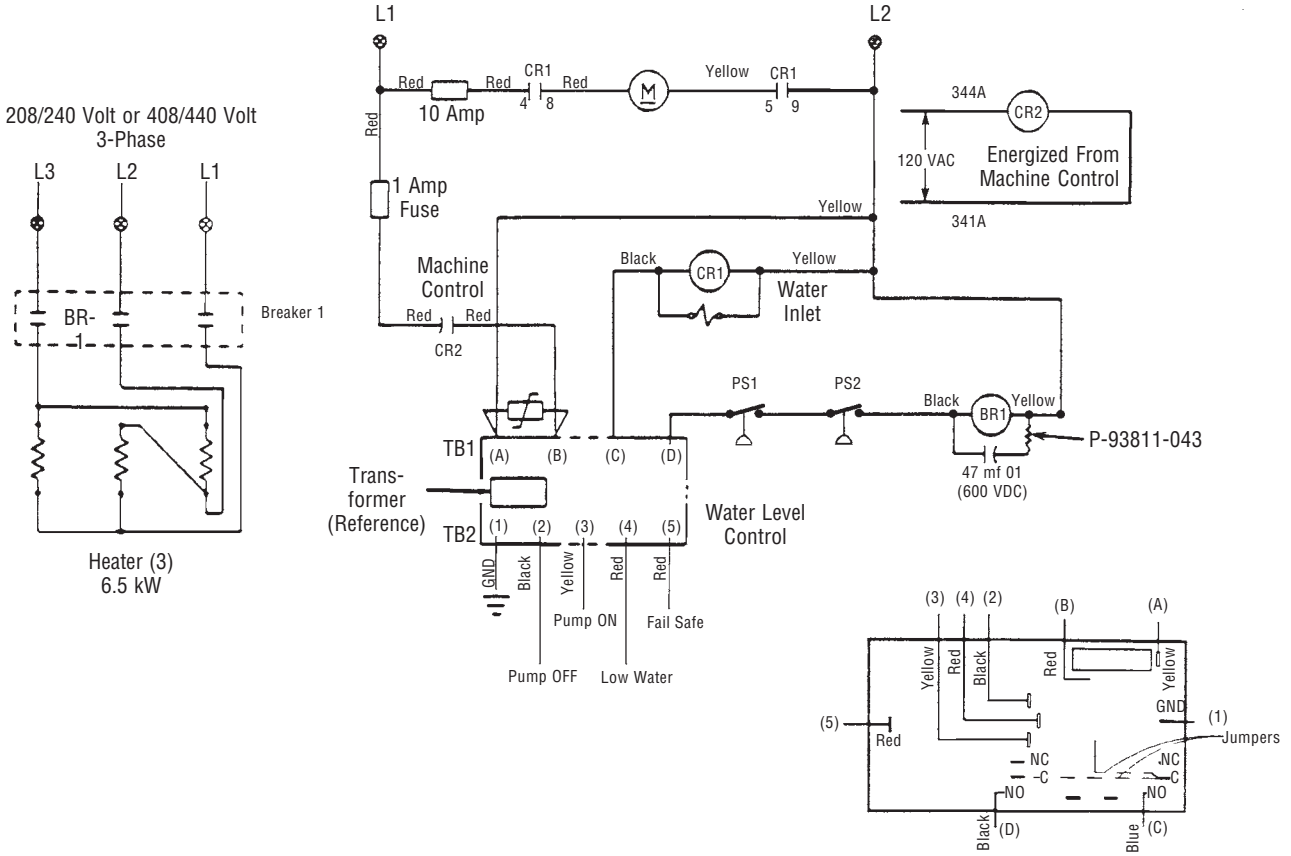


Figure 6-17. LBAS Series Solid State Control – Wiring Diagram (for units with one contactor).

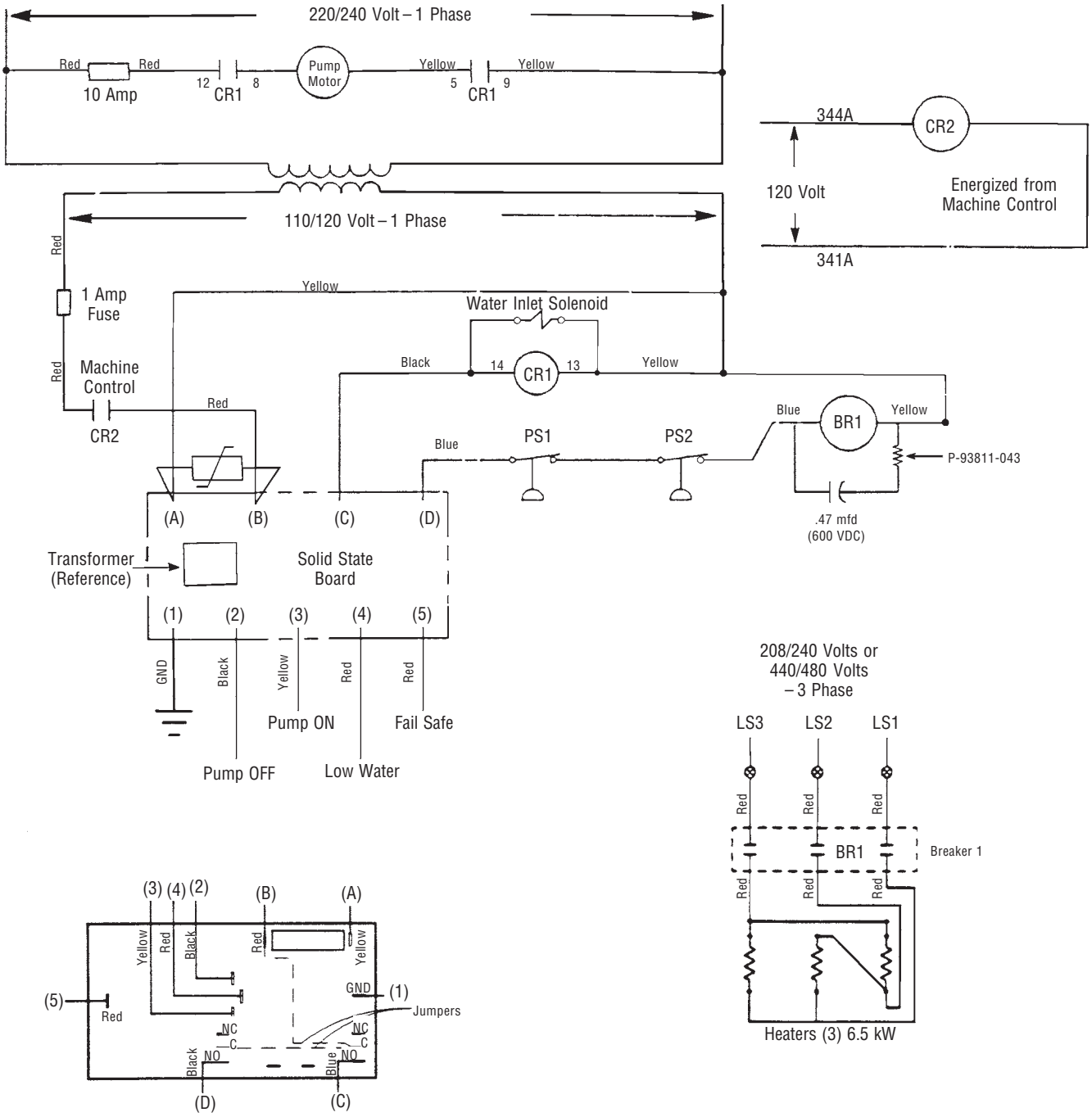


Figure 6-18. AS Series Solid State Control – Wiring Diagram (for units with one contactor and transformer).

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Section 7: Illustrated Parts Breakdown

Significant assemblies and components of the Electric Steam Generators are illustrated and identified in this section. The part number, the description, and the quantity required for each usage are given. Each indentation in the description represents the assembly level. The UNITS PER ASSEMBLY column is specific for the given assembly or subassembly level.

7.0 HOW TO USE THE ILLUSTRATED PARTS BREAKDOWN

1. Determine the function and application of the part required. Select the most appropriate title from the List of Illustrations in the Table of Contents. Note the illustration page number.
2. Turn to the page indicated and locate the desired part on the illustration.
3. From the illustration, obtain the item number assigned to the desired part. Refer to the accompanying tabular list (usually on the facing page) for the part number and description of the part.

Figure 7-1. LB Series Stand-alone Generator, External Parts 7-4
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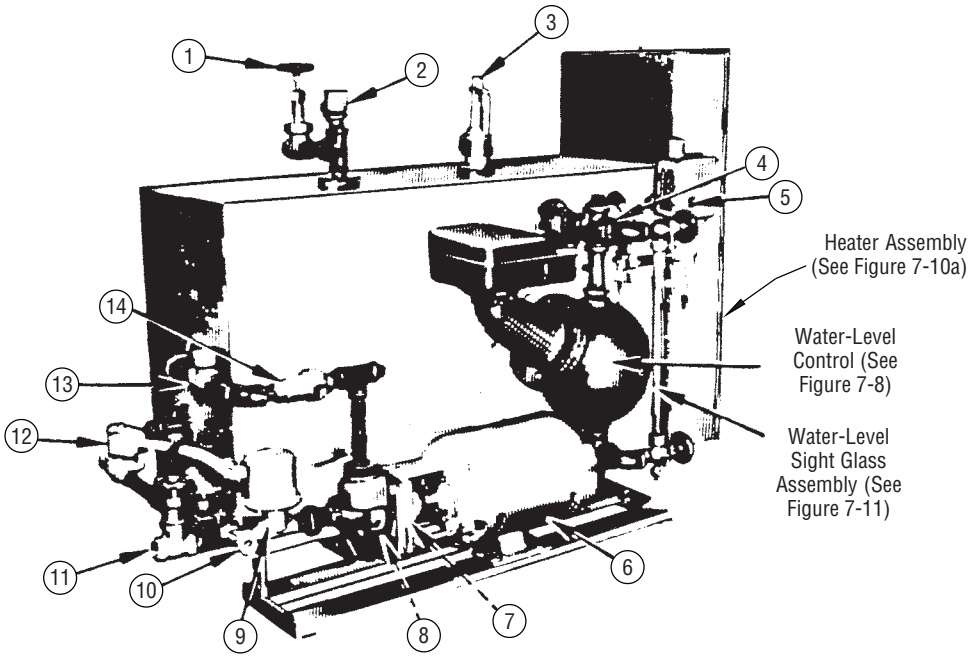

Figure 7-1a. LB Series Unit with Float-type Water-level Control (Four-digit Serial Number)

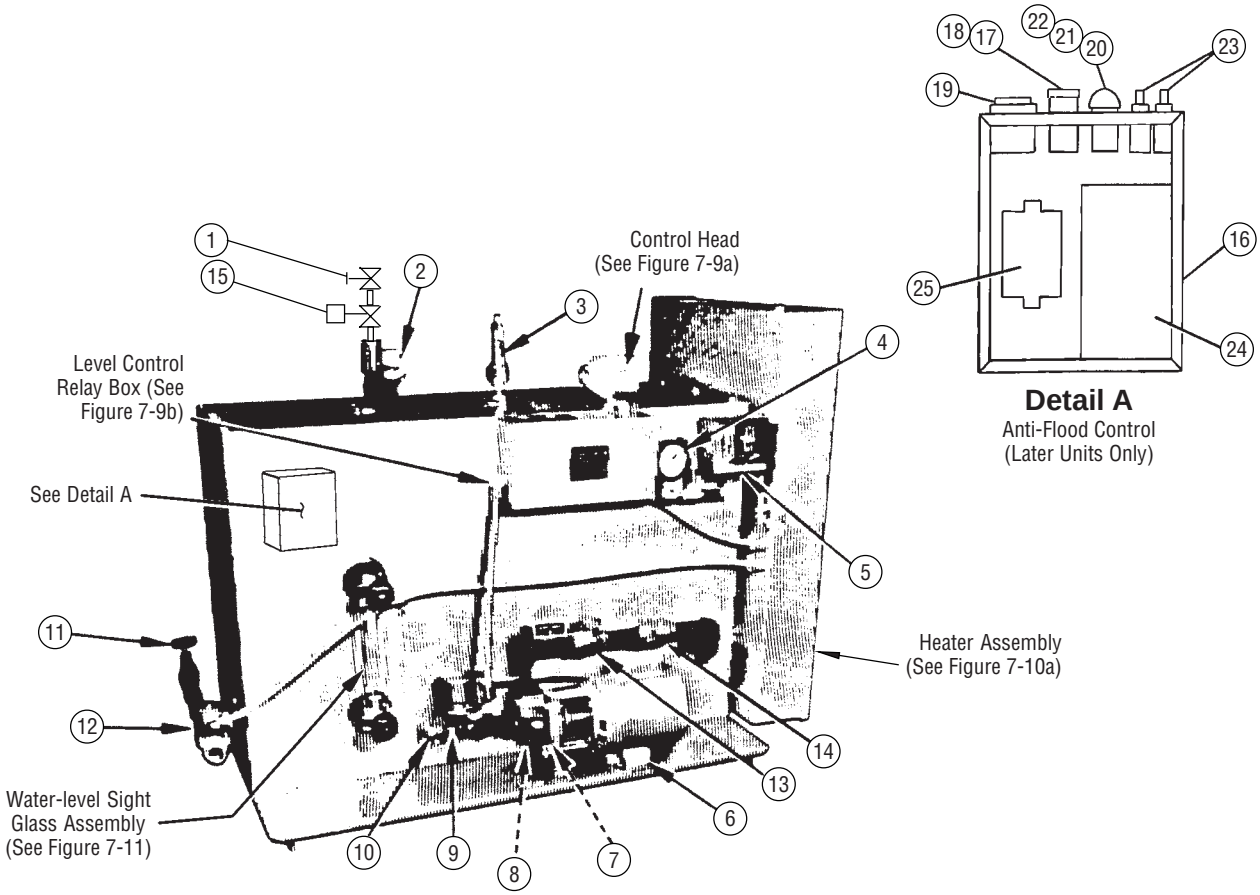

Figure 7-1b. LB Series Unit with Electric Water-level Control (Five-digit Serial Number)

Figure 7-1. LB Series Stand-alone Generator, External Parts

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-1					**LB Series Stand-alone Generator, External Parts**	X
1	P	47601	091		VALVE, Steam Outlet Ball, 3/4"	1
2	P	750569	091		RELIEF VALVE, Vacuum, 1/2"	1
	P	757588	091		• REPAIR KIT (Watts)	1
	P	764323	929		• REPAIR KIT (Conbraco)	1
	P	750569	091		RELIEF VALVE, Vacuum, 3/4"	1
3	P	764323	459		VALVE, Safety, 1/2", 100 psi	1
	P	764316	742		VALVE, Safety, 1/2", 100 psi, S/S	1
	P	764323	460		VALVE, Safety, 3/4", 100 psi	1
	P	764326	146		VALVE, Safety, 3/4", 100 psi, S/S	1
4	P	79680	001		GAUGE, Pressure, 2-1/2", (0-100 psi), S/S	1
	P	750467	091		GAUGE, Pressure, 2-1/2", (0-160 psi)	1
5	P	764055	001		PRESSURE CONTROL, Honeywell L 604 N	1
	P	764315	519		PRESSURE CONTROL, ASCO, S/S	1
	P	764319	305		PRESSURE CONTROL, Barksdale	A/R
	P	764320	389		PRESSURE COTROL, w/Manual Reset, Barksdale	A/R
	P	764315	519		PRESSURE CONTROL, Honeywell, S/S	1
	P	764328	581		MOTOR AND PUMP (MTH)	1
	P	764328	091		MOTOR AND PUMP S/S (MTH)	1
6	P	764315	522		MOTOR AND PUMP, S/S (BURKS)	1
7	P	764327	687		• SEAL ASSEMBLY	1
8	P	764327	688		• PUMP ONLY	1
6	P	750816	091	*	MOTOR AND PUMP (60 cycle) (BURKS)	1
7	P	750155	091		• SEAL ASSEMBLY w/O-ring	1
8	P	751377	091	**	• REPAIR KIT (PUMP)	1
	P	750816	004	*	• PUMP, Only	1
	P	750816	003		• MOTOR, Only, 1/3 HP, 60 Hz	1
6	P	750816	002	*	MOTOR AND PUMP (50 Cycle) (BURKS)	1
7	P	750155	091		• SEAL ASSEMBLY w/O-ring	1
8	P	751377	091	**	• REPAIR KIT (PUMP)	1
	P	750816	004	*	• PUMP, Only	1
9	P	764319	693		VALVE, Fill Solenoid (110V), 3/8"	1
	P	764321	245		• COIL	1
	P	764321	247		• REPAIR KIT	1
	P	764321	213		VALVE, Fill Solenoid (220 V), 3/8"	1
	P	764321	246		• COIL	1
	P	764321	247		• REPAIR KIT	1
	P	764315	518		VALVE, Fill Solenoid (110 V), S/S, 3/8"	1
	P	764076	002		• COIL	1

(continued)

** Pump may be periodically adjusted (see Paragraph 6.6).*

*** Includes raceway, impellers, and mechanical seal.*

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FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-1 (continued)					**LB Series Stand-alone Generator, External Parts**	X
	P	764321	244		• REPAIR KIT	1
	P	764321	241		• VALVE, Fill, Solenoid (220V), S/S, 3/8"	1
	P	764321	243		• COIL	1
	P	764321	244		• REPAIR KIT	1
10	P	763822	001		STRAINER, Water, 3/8"	1
11	P	118810	091		VALVE, Manual Drain, 1/2" (GATE)	1
	P	764315	520		VALVE, Manual Drain, 1/2", S/S	1
	P	764316	938		VALVE, Manual Drain, 3/4" (Ball)	1
12	P	750113	091	§§	VALVE, Drain and Flush Solenoid, 3/4" (220 V) 8030B43E TPL6926	1
	P	758704	091		• KIT, Repair	
	P	763959	001		• COIL	
	P	759743	001		VALVE, Drain and Flush Solenoid, 3/4" (110 V) 8030B43E TPL6926	1
	P	758704	091		• KIT, Repair	
	P	761700	001		• COIL	
13	P	753187	091		VALVE, Spring-loaded Check, 3/8"	1
	P	751368	091		VALVE, Spring-loaded Check, 1/2"	
14	P	75426	091		VALVE, Flapper, Union Check, 1/2"	1
	P	75427	091		VALVE, Flapper, Union Check, 3/8"	1
	P	764320	492		VALVE, Ball, Cone Check, 1/2"	1
	P	764321	478		VALVE, Ball, Cone Check, 1/2", S/S	1
15	P	101006	806		VALVE, Steam Outlet (110 V), 3/4"	1
	P	764324	417		• REPAIR KIT	
	P	764076	002		• COIL	
	P	617100	767		VALVE, Steam Outlet (110 V), 3/4", S/S	
	P	764324	147		• REPAIR KIT	
16	P				CONTROL BOX ASSEMBLY, Anti-flood (NLA)	1
17	P	764322	898		• FUSEHOLDER	1
18	P	764317	819		• FUSE (Box of 10)	1
19	P	93443	002		• PLUG, Receptacle	1
20	P	764322	900		• SOCKET, Light	1
21	P	764317	708		• LIGHT (Box of 10)	1
22	P	764322	901		• LENS	1
23	P	764322	899		• SWITCH, Pushbutton	2
24	P	764322	896		• PC BOARD ASSEMBLY	1
25	P	129360	019		• RELAY	1

§§ The 3/4" solenoid valve is now standard on all units. For replacement of 1/2" solenoid valves, order Kit No. P-753022-091 (220V).

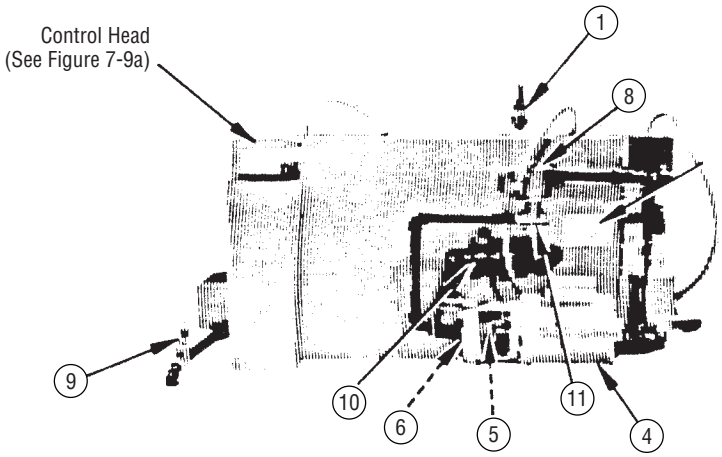

Figure 7-2a. Side View

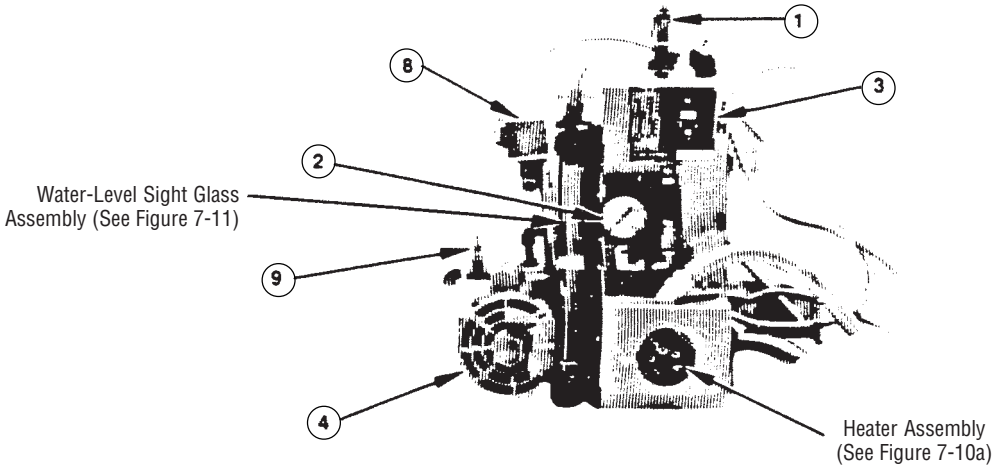

Figure 7-2b. End View

Figure 7-2. LBAS Series (Integral) Non-solid State 15 and 20 KW Generator, External Parts

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-2-					**LBAS Series Integral Non-solid State 15 and 20 KW Generator, External Parts**	X
1	P	77053	091		VALVE, Safety, 1/2", 85 psi	1
	P	764315	521		VALVE, Safety, 1/2", 85 psi, S/S	1
2	P	79680	001		GAUGE, Pressure, 2-1/2", (0-100 psi), S/S	1
	P	750467	091		GAUGE, Pressure, 2-1/2", (0-160 psi)	1
3	P	764055	001		PRESSURE CONTROL, Honeywell L604 N	
	P	764319	305		PRESSURE CONTROL, Barksdale	1
	P	764320	389		PRESSURE CONTROL, Manual Reset, Barksdale	
	P	764315	519		PRESSURE CONTROL, Asco, S/S	1
4	P	764315	522		MOTOR AND TURBINE PUMP, S/S (60 Hz) (BURKS)	1
	P	750816	091		MOTOR AND TURBINE PUMP (60 Hz) (BURKS)	1
5	P	750155	091		• SEAL ASSEMBLY	1
6	P	751377	091		• IMPELLER	1
6	P	759816	004		• PUMP (Only)	1
	P	750816	003		• MOTOR (60 Hz)	1
	P	750816	002		MOTOR AND TURBINE PUMP, (50 Hz) (BURKS)	1
5	P	750155	091		• SEAL ASSEMBLY	1
6	P	751377	091		• IMPELLER	1
6	P	750816	004		• PUMP (Only)	1
7					NOT USED	
8	P	764319	693		VALVE, Fill Solenoid (110 V), 3/8"	1
	P	764321	245		• COIL	1
	P	764317	381		• REPAIR KIT (Valve, HY212-605-1)	1
	P	764321	247		• REPAIR KIT (Valve, HV232-011-1 or HV258-549-1)	
	P	764321	213		VALVE, Fill Solenoid (220 V), 3/8"	1
	P	764321	246		• COIL	1
	P	764321	247		• REPAIR KIT (Valve, HV258-549-2)	1
	P	764315	518		VALVE, Fill Solenoid (110 V), S/S, 3/8"	1
	P	764076	002		• COIL (Valve, 8263A319)	
	P	764324	557		• COIL (Valve, 8263G319)	
	P	764321	244		• REPAIR KIT	1
	P	764321	241		VALVE, Fill Solenoid (220 V), S/S, 3/8"	1
	P	764321	243		• COIL (Valve, 8263A319)	1
	P	764329	251		• COIL (Valve, 8263G319)	1
	P	764321	244		• REPAIR KIT	1
9	P	92254	001		VALVE, Manual Drain, 1/2", S/S (Ball)	1
10	P	753187	091		VALVE, Spring-loaded Check, 3/8"	1
11	P	75426	091		VALVE, Flapper, Union Check, 1/2"	1
	P	764321	478		VALVE, Ball Cone Check, 1/8" (S/S)	1
	P	764320	492		VALVE, Ball Cone Check, 1/2"	1
	P	76947	061		VALVE, Swing Check, 1/2"	1
					Refer to paragraph 6.9 when replacing check valves.	
					**Pump on may be periodically adjusted (see paragraph 6.6).*	
					***Includes coupling for hand wheel extension and rod.*	

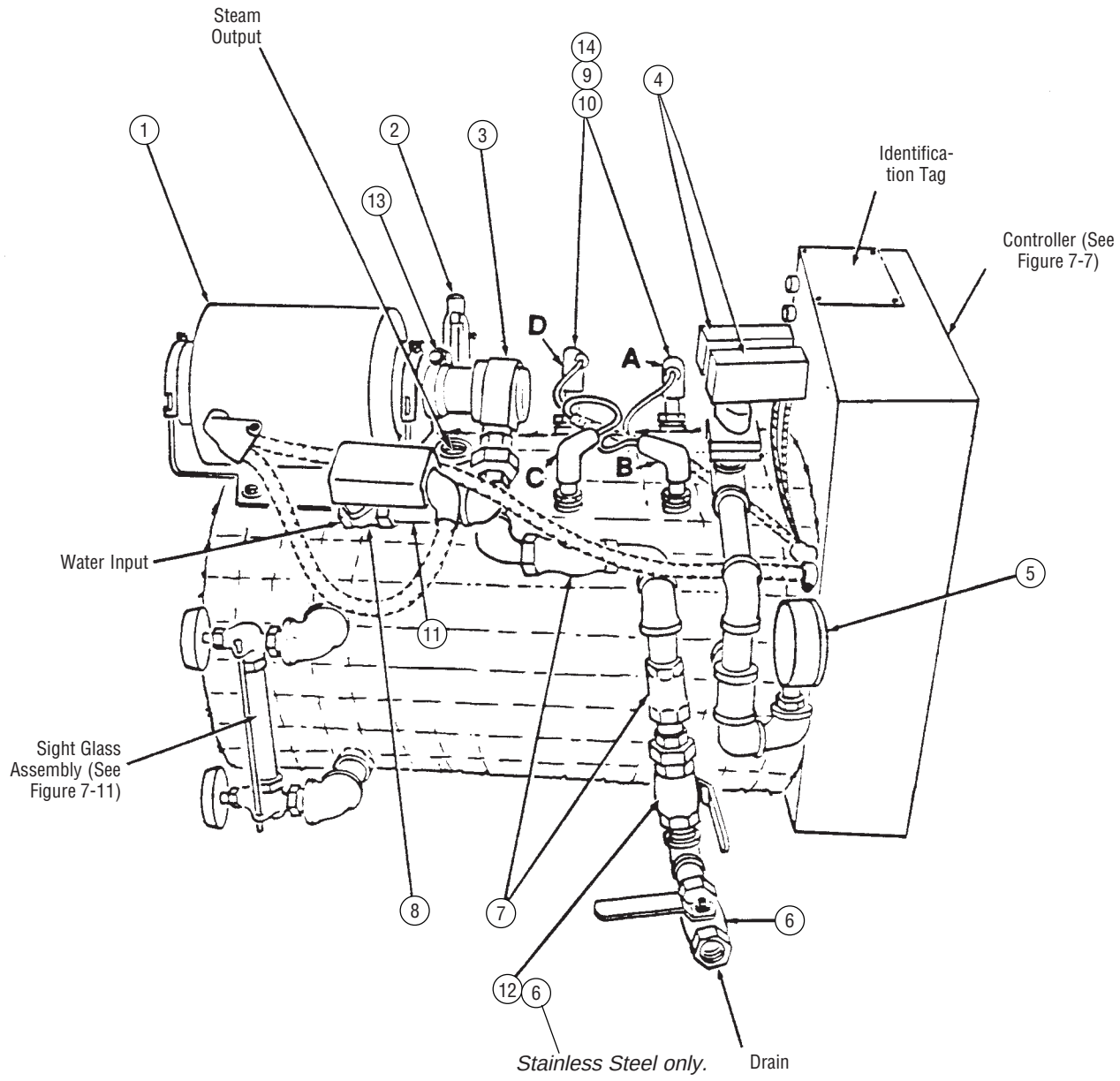

Figure 7-3. LBAS Series (Integral) Solid State 20 and 30 KW Generator, External Parts (Medallion/Eagle 2000 Sterilizers)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-3-					LBAS Series Intergral, Solid State, 20 and 30 KW Generators (Carbon Steel)	X			
					LBAS Series Intergral, Solid State, 20 and 30 KW Generators (Stainless Steel)		X		
1	P	764323	487		MOTOR, 115/230v, 50/60 Hz	1	1		
2	P	764323	459		VALVE, Safety, 100 psi	1			
	P	764316	742		VALVE, Safety, 100 psi S/S		1		
3	P	764319	902		PUMP, Rotary Vane (1.7 GPM)	1			
	P	764324	674		PUMP, Rotary Vane (1.7 GPM) S/S		1		
4	P	764319	305		SWITCH, Pressure (Operating)	1			
	P	764320	389		SWITCH, Pressure, Manual Reset (High Limit)	1			
	P	764327	607		SWITCH, Pressure (Operating)		1		
	P	764325	551		SWITCH, Pressure, Manual Reset (High Limit)		1		
5	P	750467	091		GAUGE, Pressure	1			
	P	764324	695		GAUGE, Pressure		1		
6	P	764317	863		VALVE, Ball, 1/2" NPT	1			
	P	764324	696		VALVE, Ball, 1/2" NPT		2		
7	P	764320	492		VALVE, Check, Ball Cone, 1/2"	1			
	P	764321	478		VALVE, Check, Ball Cone, 1/2"		1		
8	P	764319	693		VALVE, Solenoid, 3/8" NPT	1			
	P	764321	247		• REPAIR KIT	1			
	P	764323	940		• COIL (G Series)	1			
	P	764321	245		• COIL (D Series)	1			
	P	764315	518		VALVE, Solenoid, 3/8" NPT		1		
	P	764321	244		• REPAIR KIT		1		
	P	764076	002		• COIL (A Series)		1		
	P	764324	557		• COIL (G Series)		1		
9	P	150828	208		PROBE, Spark Plug (3/8" NPT)	4	4		
10	P	764316	748		ELECTRO-RODS (Set of Four)*, 14" lg. ea.	1	1		
11	P	076044	091		VALVE, Flow Control (2 GPM)	1			
12	P	764321	222		VALVE, Union Ball, 1/2" NPT	1			
13	P	764323	491		CLAMP, Pump	1	1		
14	P	764324	507		BOOT, Electrode (Angle)	4	4		
	P	764326	926		BOOT, Electrode (Straight)	4	4		
15	P	764328	028		AUTO FLUSH AND DRAIN KIT (Not Shown)	1			
					** Cut rods as follows:*				
					A = 5-1/2" (140 mm) (red wire) Low Water				
					B = 4" (102 mm) (yellow wire) Pump On				
					C = 3-1/2" (89 mm) (black wire) Pump Off				
					D = 5-1/2" (140 mm) (red wire) Ground				

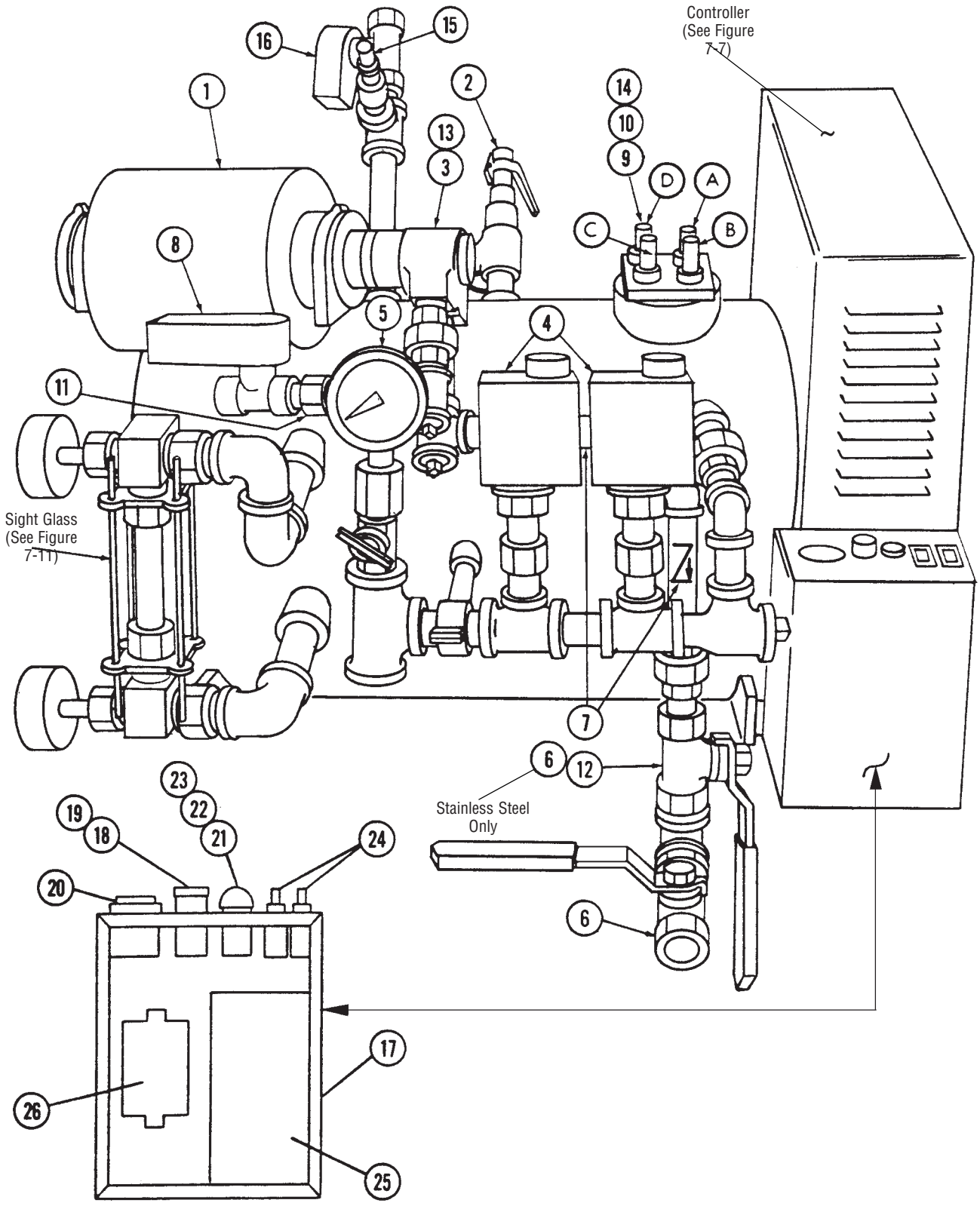

Figure 7-4. LBAS Series (Integral) Solid State 30KW Generator, External Parts (Eagle 3000 Stage 2)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-4-					**LBAS Series (Integral) Solid State 30 KW Generator (Carbon Steel)**	X			
					LBAS Series (Integral) Solid State 30 KW Generator (Stainless Steel)		X		
1	P	763323	487		MOTOR, 115/230 V, 50/60 Hz	1	1		
2	P	764323	459		VALVE, Safety, 100 psi	1			
	P	764316	742		VALVE, Safety, 100 psi S/S		1		
3	P	764319	902		PUMP, Rotary Vane (1.7 GPM)	1			
	P	764324	674		PUMP, Rotary Vane (1.7 GPM) S/S		1		
4	P	764319	305		SWITCH, Pressure (Operating)	1			
	P	764327	607		SWITCH, Pressure (Operating)		1		
	P	764320	389		SWITCH, Pressure, Manual Reset (High Limit)	1			
	P	764325	551		SWITCH, Pressure, Manual Reset (High Limit)		1		
5	P	750467	091		GAUGE, Pressure	1			
	P	764324	695		GAUGE, Pressure		1		
6	P	764317	863		VALVE, Ball, 1/2" NPT	1			
	P	764324	696		VALVE, Ball, 1/2" NPT		2		
7	P	764320	492		VALVE, Check, Ball Cone, 1/2"	1			
	P	764321	478		VALVE, Check, Ball Cone, 1/2"		1		
8	P	764319	693		VALVE, Solenoid, 3/8" NPT	1			
	P	764321	247		• REPAIR KIT	1			
	P	764323	940		• COIL (G Series)	1			
	P	764321	245		• COIL (D Series)	1			
	P	764315	518		VALVE, Solenoid, 3/8" NPT		1		
	P	764321	244		• REPAIR KIT		1		
	P	764076	002		• COIL (A Series)		1		
	P	764324	557		• COIL (G Series)		1		
9	P	756383	091		PROBE, Spark Plug (5/8-24 Screw Thread)	4	4		
	P	150828	208		PROBE, Spark Plug (3/8" NPT)	4	4		
10	P	764316	748		ELECTRO-RODS (Set of Four)*, 14" long each	1	1		
11	P	076044	091		VALVE, Flow Control (2 GPM)	1			
12	P	764321	222		VALVE, Union Ball, 1/2" NPT	1			
13	P	764323	491		CLAMP, Pump	1	1		

(continued)

** Cut rods as follows:*

A = 5-1/2" (140 mm) (red wire) Low Water

B = 4-1/2" (114 mm) (yellow wire) Pump Off

C = 4" (102 mm) (black wire) Pump On

D = 5-1/2" (140 mm) (red wire) Ground

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FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-4- (continued)					**LBAS Series (Integral) Solid State 30 KW Generator (Carbon Steel)**	**X**			
					LBAS Series (Integral) Solid State 30 KW Generator (Stainless Steel)		**X**		
14	P	764324	507		BOOT, Electrode (Angle)	5	5		
	P	764326	926		BOOT, Electrode (Straight)	5	5		
15	P	764323	515		PROBE, Spark Plug (3/8" NPT)	1	1		
16	P	101006	805		VALVE, Solenoid, 1/2" NPT	1			
	P	764324	556		• REPAIR KIT	1			
	P	764076	002		• COIL	1			
	P	617100	766		VALVE, Solenoid, 1/2" NPT		1		
	P	764324	147		• REPAIR KIT		1		
17	–				CONTROL BOX ASSEMBLY, Anti-flood (NLA)				
18	P	764322	898		• FUSE HOLDER	1	1		
19	P	764317	819		• FUSE (Box of 10)	1	1		
20	P	93443	002		• PLUG, Receptacle	1	1		
21	P	764322	900		• SOCKET, Light	1	1		
22	P	764317	708		• LIGHT (Box of 10)	1	1		
23	P	764322	901		• LENS	1	1		
24	P	764322	899		• SWITCH, Pushbutton	2	2		
25	P	764325	965		• PC BOARD ASSEMBLY (High Sensitivity)		1		
	P	764322	896		• PC BOARD ASSEMBLY	1			
26	P	129360	019		• RELAY	1	1		
27	P	764328	028		AUTO FLUSH AND DRAIN KIT (Not Shown)	1			

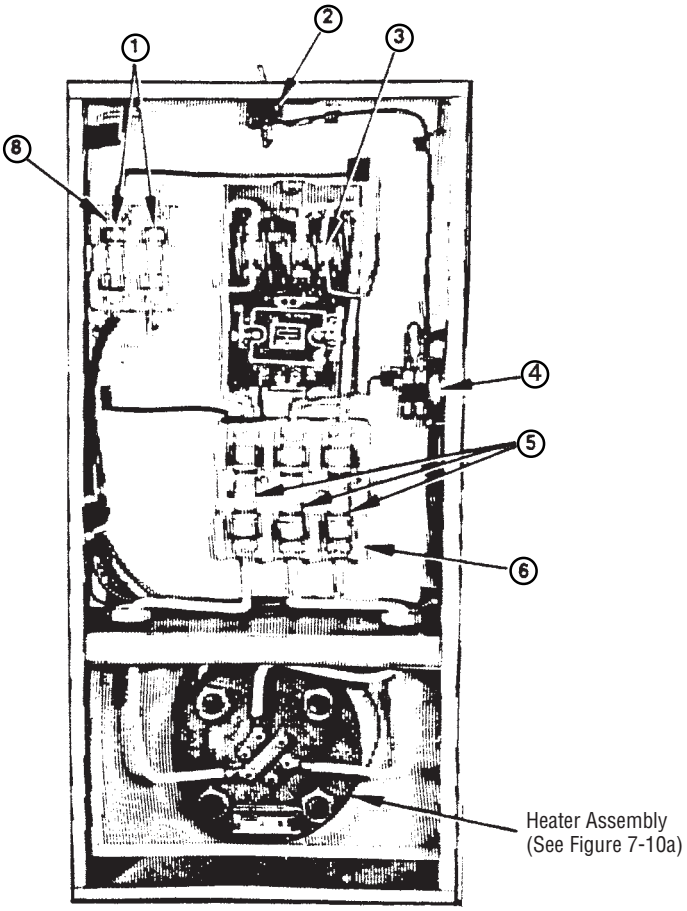

Figure 7-5. LB Series Electrical Components

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-5-					**LB Series Electrical Components**	X
1	P	764317	769		FUSE, Control Circuit, 15 Amp (Box of 10)	1
2	P	750828	091		SWITCH, Pilot Toggle (DPST)	1
	P	764324	340		SWITCH, Pilot Toggle (SPDT)	1
3	P	759745	001		CONTACTOR, 30 Amp Res., 120 Volt, Furnas 41NB30AFM	A/R
	P	759749	001		• COIL	1
	P	759080	091		• POINTS (Per Pole)	3
	P	757936	091		CONTACTOR, 30 Amp Res., 220 Volt, Furnas, 41NB30GM	A/R
	P	759079	091		• COIL	1
	P	759080	091		• POINTS (Per Pole)	3
	P	759747	001		CONTACTOR, 50 Amp Res., 120 Volt, Furnas, 42CF35AF	A/R
	P	759749	001		• COIL	1
	P	759081	091		• POINTS (Per Pole)	3
	P	759252	091		CONTACTOR, 50 Amp Res., 220 Volt, Furnas, 42CF35AG	A/R
	P	759079	091		• COIL	1
	P	759081	091		• POINTS (Per Pole)	3
	P	759748	001		CONTACTOR, 60 Amp Res., 120 Volt, Furnas, 42DE35AF	A/R
	P	759749	001		• COIL	1
	P	759081	091		• POINTS (Per Pole)	3
	P	757937	091		CONTACTOR, 60 Amp Res., 220 Volt, Furnas, 42DF35AG	A/R
	P	759079	091		• COIL	1
	P	759002	091		• POINTS (Per Pole)	3
4	P	751485	091		TIMER, Repeat Cycle (220 V), Auto Flush and Drain	1
	P	752341	091		• MICROSWITCH	
	P	759741	001		TIMER, Repeat Cycle (120 V), Auto Flush and Drain	1
	P	752341	091		• MICROSWITCH	
	P	764320	827		TIMER, Repeat Cycle (Artison, Solid-State), Auto Flush and Drain	1
5	P	764317	816	§	FUSE, 30 Amp, 250 Volt (Box of 10)	A/R
	P	764317	774	§	FUSE, 30 Amp, 600 Volt (Box of 10)	A/R
	P	752057	091	§	FUSE, 40 Amp, 250 Volt (ea.)	A/R
	P	764317	820	§	FUSE, 40 Amp, 600 Volt (Box of 10)	A/R
	P	764317	838	§	FUSE, 50 Amp, 250 Volt (Box of 10)	A/R
	P	764321	695	§	FUSE, 50 Amp, 250 Volt (Fiberglass) (ea.)	A/R
	P	764317	839	§	FUSE, 50 Amp, (SC50), 300 Volt (Box of 2)	A/R
	P	756313	091	§	FUSE, 50 Amp, 600 Volt (ea.)	A/R
	P	764320	434	§	FUSE, 50 Amp, 600 Volt (Fiberglass) (ea.)	A/R
	P	764317	770	§	FUSE, 60 Amp, 250 Volt (Box of 10)	A/R
	P	764320	809	§	FUSE, 60 Amp, 250 Volt (Fiberglass) (ea.)	A/R
	P	764317	840	§	FUSE, 60 Amp (SC60), 300 Volt, LB180 (Box of 2)	A/R
	P	764323	443	§	FUSE, 60 Amp, 600 Volt (ea.)	A/R

(continued)

§ Refer to Paragraph 6.7.1 when replacing fuses.

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FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-5- (continued)					**LB Series Electrical Components**	**X**
6	P	764315	607		FUSE HOLDER, 3 Pole, (for SC50, SC60 Amp, 300 Volt, 2-1/4" Long Fuses)	A/R
	P	750400	091		FUSE HOLDER, 3 Pole, (for 40, 50, 60 Amp, 250 Volt, 3" Long Fuses [Porcelain])	A/R
	P	752480	091		FUSE HOLDER, Single Pole, (for 30 Amp, 600 Volt, 5" Long Fuses)	A/R
	P	764320	945		FUSE HOLDER, Single Pole, (for 30 Amp, 600 Volt, 5" Long Fuses [Porcelain])	A/R
	P	764315	352		FUSE HOLDER, Single Pole, (for 40, 50, 60 Amp, 600 Volt, 5-1/2" Long Fuses)	A/R
	P	764319	593		FUSE HOLDER, Single Pole, (for 40, 50, 60 Amp, 600 Volt, 5-1/2" Long Fuses [Porcelain])	A/R
	P	764316	247		FUSE HOLDER, 3-Pole (for 40, 50, 60 Amp, 600V, 5-1/2" Long Fuses)	A/R
7	P	764319	887		BLOCK, Terminal, 3 PH (Not Shown)	A/R
8	P	18277	091		FUSE HOLDER, for 15 Amp Fuse, Item 1)	A/R
9	P	764321	887		SOLENOID, Door Interlock (CA Code) (Not Shown)	1
10	P	150461	001		BLOCK, Terminal, 1 PH (Not Shown)	1
11	P	764319	003		TRANSFORMER, 440V TO 110V (1 KVA) (Not Shown)	1
	P	764321	890		• FUSE HOLDER	1
	P	764321	782		• FUSE, 5 Amp (Box of 5)	A/R
	P	764323	688		• FUSE, 10 Amp (Box of 5)	A/R

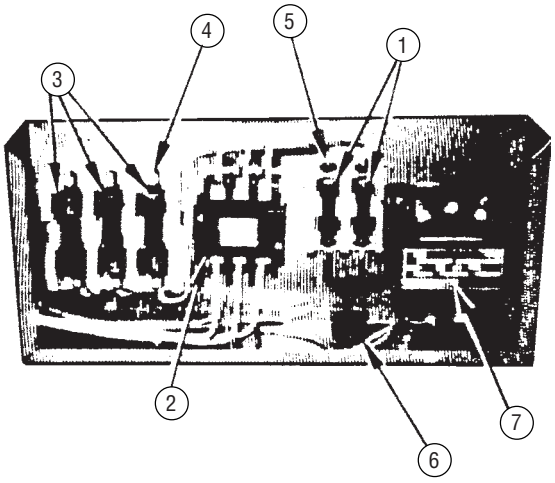


Figure 7-6. LBAS Series (Integral) Non-solid State, Electrical Components

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-6-					LBAS Series (Integral) Non-soild State Electrical Components	X
1	P	764317	769		FUSE, Control, 15 Amp (Box of 10)	2
2	P	757936	091		CONTACTOR, 30 Amp Res., 220 Volt, Furnas, 41NB30AGM	A/R
	P	759079	091		• COIL (Not Shown)	A/R
	P	759080	091		• POINTS (Per Pole) (Not Shown)	A/R
	P	759745	001		CONTACTOR, 30 Amp Res., 120 Volt, Furnas, 41NB30AFM	A/R
	P	759749	001		• COIL (Not Shown)	A/R
	P	759080	091		• POINTS (Per Pole) (Not Shown)	A/R
	P	759252	091		CONTACTOR, 50 Amp Res., 220 Volt, Furnas, 42CF35AFM	A/R
	P	759749	001		• COIL (Not Shown)	A/R
	P	759080	091		• POINTS (Per Pole) (Not Shown)	A/R
	P	759747	001		CONTACTOR, 50 Amp Res., 120 Volt, Furnas, 42CF35AF	A/R
	P	759749	001		• COIL (Not Shown)	A/R
	P	759081	091		• POINTS (Per Pole) (Not Shown)	A/R
	P	757937	091		CONTACTOR, 60 Amp Res., 220 Volt, Furnas, 42DF35AG	A/R
	P	759079	091		• COIL (Not Shown)	A/R
	P	759002	091		• POINTS (Per Pole) (Not Shown)	A/R
	P	759748	001	*	CONTACTOR, 60 Amp Res., 120 Volt, Furnas, 42DF35AF	A/R
	P	759749	001	•	COIL (Not Shown)	A/R
	P	759002	091	•	POINTS (Per Pole) (Not Shown)	A/R
3	P	764317	774	*	FUSE, 30 Amp, 600 volt (Box of 10)	A/R
	P	764317	820	*	FUSE, 40 Amp, 600 volt (Box of 10)	A/R
	P	764317	838	*	FUSE, 50 Amp, 250 volt (Box of 10)	A/R
	P	764321	695	*	FUSE, 50 Amp, 250 volt (Fiberglass) (ea.)	A/R
	P	764317	839	*	FUSE, 50 Amp, (SC50), 300 volt (Box of 2)	A/R
	P	756313	091	*	FUSE, 50 Amp, 600 volt	A/R
	P	764320	434	*	FUSE, 50 Amp, 600 volt (Fiberglass) (ea.)	A/R
	P	764317	770	*	FUSE, 60 Amp, 250 volt (Box of 10)	A/R
	P	764320	809	*	FUSE, 60 Amp, 250 volt (Fiberglass) (ea.)	A/R
	P	746317	840	*	FUSE, 60 Amp, (SC60), 300 volt (Box of 2)	A/R
4	P	764315	352		FUSE HOLDER, Single Pole (for 40, 50, and 60 Amp, 600 Volt, 5-1/2" Lg. Fuse)	A/R
	P	750400	091		FUSE HOLDER, 3 Pole (for 40, 50, and 60 Amp, 250 Volt, 3" Lg. Fuse [Porcelain])	A/R
	P	752480	091		FUSE HOLDER, Single Pole (for 30 Amp, 600 Volt, 5" Lg. Fuses)	A/R
	P	764315	607		FUSE HOLDER, 3 Pole (for SC50, SC60 Amp, 300 Volt, 2-1/4" Lg. Fuse)	A/R
	P	764319	593		FUSE HOLDER, Single Pole (for 40, 50, and 60 Amp, 600 Volt, 5-1/2" Lg. Fuse [Porcelain])	A/R
	P	764320	945		FUSE HOLDER, Single Pole (for 30 amp, 600 Volt, 5" Lg. Fuses [Porcelain])	A/R
5	P	18277	091		FUSE BLOCK - 2 POLE (for 15 Amp fuse, Item 1)	1
6	P	37606	091		RELAY	1
7	P	764326	132		TRANSFORMER, 208/240 V TO 120 V (0.10 KVA)	1
8	P	764321	200		BLOCK, Terminal, 3 PH (Not Shown)	1
9	P	150461	001		BLOCK, Terminal, 1 PH (Not Shown)	1

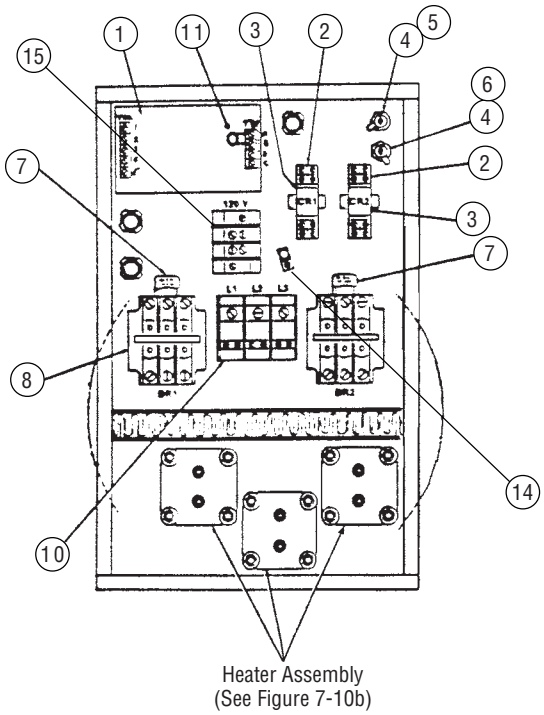


Figure 7-7. LBAS Series (Integral) Solid State, Electrical Components

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-7-					**LBAS Series (Integral) Solid State Electrical Components ..**	**X**
1	P	764322	032		LEVEL CONTROL CIRCUIT BOARD (SN27871 and lower)	1
	P	755715	735		LEVEL CONTROL CIRCUIT BOARD (SN27872 and higher)	1
2	P	84412	001		SOCKET, Relay	2
3	P	84413	001		RELAY, Plug-in, 120 VAC	2
4	P	91713	091		FUSE HOLDER	A/R
5	P	764320	604		FUSE, 8 Amp (Before 3/87, Box of 5)	1
	P	764323	556		FUSE, 10 Amp (After 3/87, Box of 5)	1
6	P	764317	462		FUSE, 1 Amp (Box of 5)	1
7	P	764320	233		CAPACITOR, .47 mfd, 600 VDC	2
8	P	759747	001		CONTACTOR, 50 Amp	A/R
	P	759748	001		CONTACTOR, 60 Amp	A/R
9	P	56396	236		CABLE ASSEMBLY, Generator to Control Column (Not Shown)	1
10	P	764321	200		BLOCK, Terminal (3 PH)	1
11	P	150778	001		VARISTOR (SN27871 and lower)	1
12	P	764326	132		TRANSFORMER, 0.10KVA (Not Shown)	1
13	P	93811	043		RESISTOR, ½ W, 150 Ohm (SN27871 and lower) (Not Shown)	1
	P	129318	001		RESISTOR, 10 W, 3000 Ohm (Not Shown)	1
14	P	764323	333		LUG, Grounding	1
15	P	150461	001		BLOCK, Terminal, 1 PH	A/R

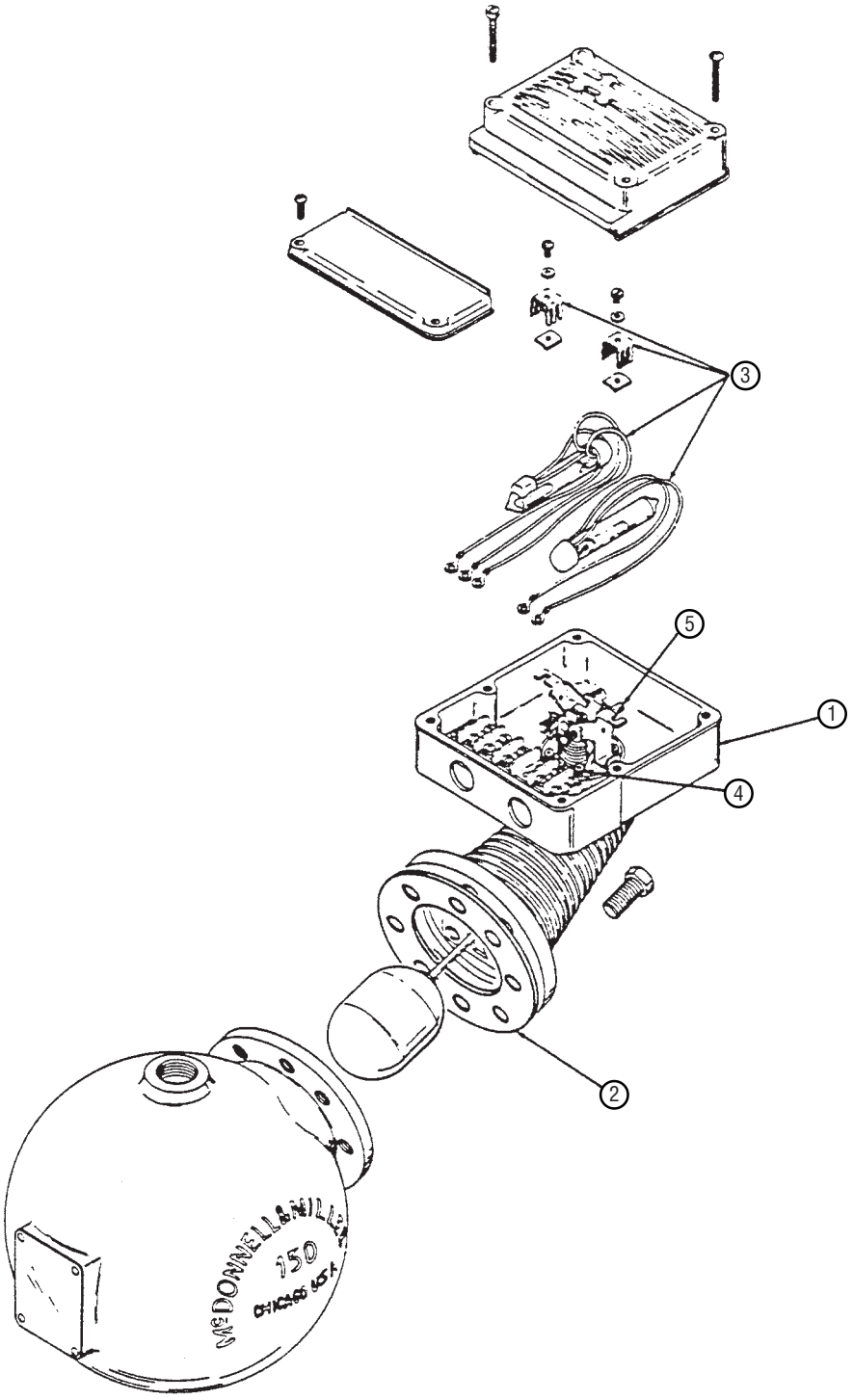
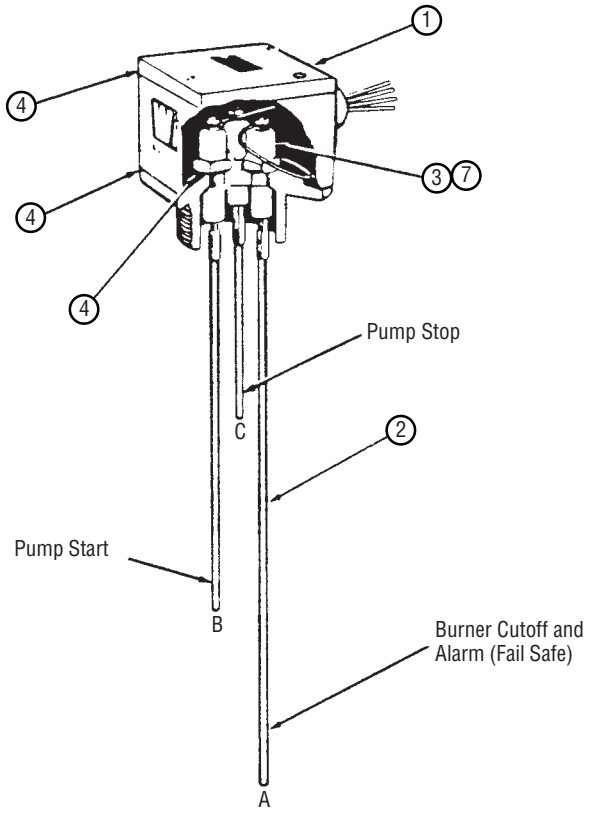
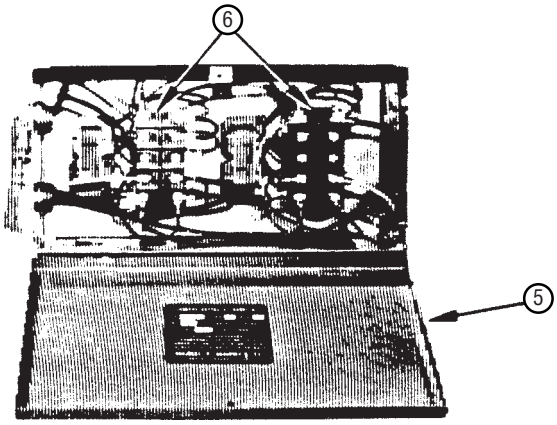


Figure 7-8. Float-type Water-level Control

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-8					**Float Type Water Level Control**	**X**
	P	753062	091		Water Level Control, McDonnel and Miller 150, High Pressure	1
1	P	753062	091		• HEAD ASSEMBLY, Control Low Water Cutoff	1
2	P	750440	091		• GASKET (HEAD)	1
3	P	750473	091		• SWITCH SET (set includes one 3-wire and one 2-wire switch)	1
4	P	752304	091		BELLOWS and GASKET SET	1
5	P	757192	091		CLAMP ASSEMBLY, Bellows Base	1
6	P	764317	452		WATER LEVEL CONTROL (Not Shown)	1
					Mercoid Series 75 (Stainless-steel Units Only)	1
	P	764321	405		• GASKET SET	1
	P	764317	532		• SWITCH	1
	P	764319	430		• TORQUE TUBE	1
	P	764317	923		• PACKING GLAND	1



7-9a. Water-Level Control



7-9b. Level Control Relay Box

Figure 7-9. Floatless-type Water-level Control (LB and LBAS Series Non-solid State)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-9-					**Floatless-type Water-level Control ..... (LB and LBAS Series Non-solid State Units)**	**X**
1	P	752476	091		* CONTROL HEAD ..... with three Threaded Electrodes (Model 3E3A)	1
	P	764316	746		* CONTROL HEAD ..... with four Pressed-in Electrodes (Model 2724A)	1
	P	764327	807		* CONTROL HEAD ..... with four Threaded Electrodes (Model 3E4A)	1
2	P	750409	091		**RODS, Brass (Set of Three, 14" long)	1
	P	764091	001		**RODS, Stainless Steel (Set of Three, 14" long)	1
	P	764316	748		**RODS, Stainless Steel (Set of Four, 14" Long)	1
3	P	756383	091		ELECTRODE, Spark Plug (threaded)	A/R
	P	764319	420		ELECTRODE, Spark Plug (press-in)	A/R
4	P	753089	091		GASKET KIT (includes housing cover, housing, and electrode gaskets)	1
5	P	77054	091		CONTROL, Liquid Level (220V)	2
	P	759744	001		CONTROL, Liquid Level (110V)	2
6	P	37318	091		RELAY, Liquid Level (220V), 1D2D0	2
	P	74473	091		RELAY, Liquid Level (110V), 1D1D0	2
	P	764324	508		RELAY, Liquid Level (110V), 1G1D0	2
	P	764321	049		RELAY, Liquid Level (220V), 1H2D0	2
	P	764319	346		RELAY, Liquid Level (220V), 2G2F0 ..... 100,000 Ohm Sensitivity	2
	P	764325	766		RELAY, Liquid Level, Solid State, 16MF1MO ..... 470,000 Ohm Sensitivity (Plug-in Type) SS Only	2
	P	764327	798		RELAY, Liquid Level, Solid-state, ... 16MB1B0 10,000 Ohm Sensitivity (Plug-in Type) SS Only	2
	P	764322	410		RELAY, Liquid Level, Solid-state, ... 16HMJ1A0 5,500,000 Ohm Sensitivity (Plug-in Type) SS Only	2
7	P	764316	314		KIT, Probe (Brass) includes three electrodes ..... (P-756383-091), Gasket Set (Item 4), and set of brass rods (P-750409-091)	1
	P	764316	315		KIT, Probe (Stainless Steel), includes three electrodes ..... (P-756383-091), gasket set (Item 4) and set of Stainless-steel rods (P-764091-001)	1

** Includes housing, housing cover, housing gasket, and electrode.*

*** Must be cut to correct length at installation.*

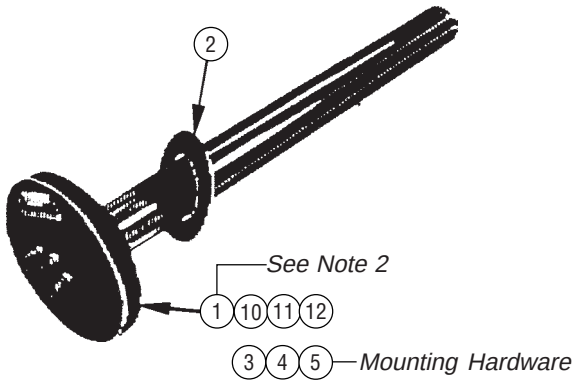


Figure 7-10a. Non-solid State Heater Assembly (Integral and Stand-alone)

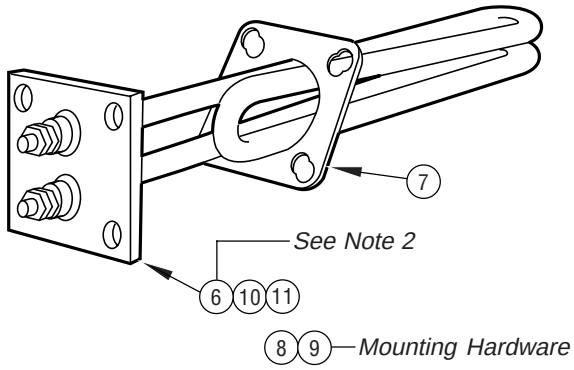


Figure 7-10b. Solid State Heater Assembly (Integral Only)

NOTE: 1. Sequentially torque all heater nuts/bolts to 200 +10/-0 in/lb
2. All heaters include heater gasket.

Figure 7-10 LB and LBAS Heater Assembly

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-10-					**Heater Assembly**	
1	P	752709	091		HEATER, 15 KW (208V)	A/R
	P	764315	577		HEATER, 15 KW (208V), Stainless Steel	A/R
	P	77318	091		HEATER, 15 KW (240V)	A/R
	P	764315	578		HEATER, 15 KW (240V), Stainless Steel	A/R
	P	756204	091		HEATER, 15 KW (380V)	A/R
	P	764315	579		HEATER, 15 KW (380/415V), Stainless Steel	A/R
	P	759246	001		HEATER, 15 KW (415V)	A/R
	P	754749	091		HEATER, 15 KW (480V)	A/R
	P	764315	580		HEATER, 15 KW (480V), Stainless Steel	A/R
	P	764322	469		HEATER, 15 KW (575/600V)	A/R
	P	78826	091		HEATER, 20 KW (208V)	A/R
	P	764315	581		HEATER, 20 KW (208V), Stainless Steel	A/R
	P	75425	091		HEATER, 20 KW (240V)	A/R
	P	764315	582		HEATER, 20 KW (240V), Stainless Steel	A/R
	P	764317	564		HEATER, 20 KW (380V)	A/R
	P	764315	583		HEATER, 20 KW (380/415V), Stainless Steel	A/R
	P	759362	091		HEATER, 20 KW (415V)	A/R
	P	750382	091		HEATER, 20 KW (480V)	A/R
	P	764315	584		HEATER, 20 KW (480V), Stainless Steel	A/R
	P	114492	091		HEATER, 20 KW (575/600V)	A/R
	P	759377	091		HEATER, 25 KW (208V)	A/R
	P	764319	441		HEATER, 25 KW (208V), Stainless Steel	A/R
	P	753854	091		HEATER, 25 KW (240V)	A/R
	P	764319	442		HEATER, 25 KW (240V), Stainless Steel	A/R
	P	764316	031		HEATER, 25 KW (380V), Stainless Steel	A/R
	P	764316	029		HEATER, 25 KW (380/415V)	A/R
	P	764319	443		HEATER, 25 KW (415V), Stainless Steel	A/R
	P	753994	091		HEATER, 25 KW (480V)	A/R
	P	764314	444		HEATER, 25 KW (480V), Stainless Steel	A/R
	P	115851	000		HEATER, 25 KW (575/600V)	A/R
	P	758665	091		HEATER, 30 KW (208V)	A/R
	P	764321	563		HEATER, 30 KW (208V), Stainless Steel	A/R
	P	753750	091		HEATER, 30 KW (240V)	A/R
	P	764321	564		HEATER, 30 KW (240V), Stainless Steel	A/R
	P	759940	001		HEATER, 30 KW (380V)	A/R
	P	764321	565		HEATER, 30 KW (380/415V), Stainless Steel	A/R
	P	761959	001		HEATER, 30 KW (415V)	A/R
	P	753995	091		HEATER, 30 KW (480V)	A/R
	P	764321	566		HEATER, 30 KW (480V), Stainless Steel	A/R
	P	114650	091		HEATER, 30 KW (575/600V)	A/R
	P	764321	469		HEATER, Indirect (Integral), Stainless Steel	A/R
	P	764321	344		HEATER, Indirect (Stand Alone)	A/R
	P	764324	729		HEATER, Indirect (Stand Alone), Stainless Steel	A/R
	P	310612	091		FLANGE, Heater (Blind)	A/R
2	P	764321	472		GASKET, Heater (Set of Three)	A/R

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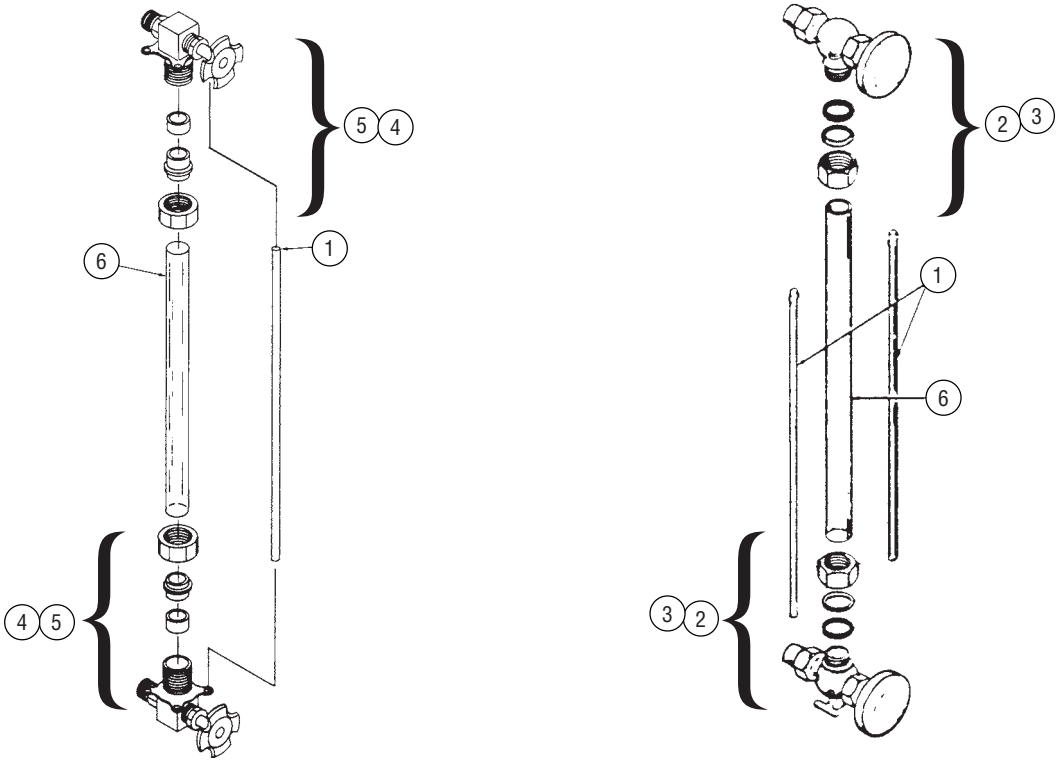
FIG. & ITEM NO.	PART NUMBER	SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-10-	(continued)		**Heater Assembly**	
3	P 764327 613		BOLT, Heater (5/8-11 x 2-1/2)	A/R
4	P 32467 061		NUT (5/8-11)	A/R
5	P 19692 061		LOCK WASHER	A/R
6	P 764319 903		HEATER, 6.5 KW (208/240/380/415V)	A/R
	P 764321 272		HEATER, 6.5 KW (208/240/380/415V), Stainless Steel	A/R
	P 764319 916		HEATER, 6.5 KW (480V)	A/R
	P 764321 398		HEATER, 6.5 KW (480V), Stainless Steel	A/R
	P 764329 282		HEATER, 6.5 KW (575/600V)	A/R
	P 764322 460		HEATER, 9.75 KW (208/240/380/415V)	A/R
	P 764322 394		HEATER, 9.75 KW (208/240/380/415V), Stainless Steel	A/R
	P 764322 882		HEATER, 9.75 KW (480V)	A/R
	P 764322 395		HEATER, 9.75 KW (480V), Stainless Steel	A/R
	P 764329 283		HEATER, 9.75 KW (575/600V)	A/R
7	P 764317 713		GASKET, Heater (Set of 3)	A/R
8	P 764323 643		BOLT, Heater (5/16-18 x 1)	A/R
9	P 19172 061		NUT (5/16-18)	A/R
10	P 764316 967		WIRE, Heater (U/M ft)	A/R
11	P 764326 920		TERMINAL, Wire	A/R
12	P 759078 091		JUMPERS AND NUTS FOR HEATER TERMINALS (SET)	A/R



Square Valve Body **Round Valve Body**

Figure 7-11. LB and LBAS Water-level Sight Glass Assembly

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-11-					**Water-level Sight Glass Assembly**	**X**
1	P	751384	091		HEAD ASSEMBLY, Control Low Water Cutoff	1
2	P	750507	091		VALVE SET (Top and Bottom)	1
	P	750363	091		• VALVE, Top	1
	P	750363	002		• VALVE, Bottom	1
	P	761847	001		• COLLAR, Retaining	2
	P	764326	361		• WASHER, Stainless Steel	2
	P	751847	091		• SEAL, Teflon Hyplon (ea.)	A/R
	P	200000	002		• SEAL, EPDM (ea.)	A/R
	P	764326	712		• VALVE, Drain	1
3	P	764329	026		VALVE SET, Long Shank (Top and Bottom)	1
	P	761847	001		• COLLAR, Retaining	2
	P	764326	361		• WASHER, Stainless Steel	2
	P	751847	091		• SEAL, Teflon Hyplon (ea.)	A/R
	P	200000	001		• SEAL, EPDM (ea.)	A/R
	P	763326	712		• VALVE, Drain	1
4	P	764323	512		VALVE SET, Brass (Top and Bottom)	1
	P	764320	900		• VALVE, Top	1
	P	764320	899		• VALVE, Bottom	1
	P	764322	052		• SEAL, Teflon Hyplon (ea.)	A/R
	P	764326	231		• SEAL, Teflon (Set of 2)	A/R
	P	764326	712		• VALVE, Drain	1
	P	764326	361		• WASHER, Stainless Steel	2
	P	764328	203		• REPAIR KIT	A/R
5	P	764315	523		VALVE SET, Stainless Steel (Top and Bottom)	1
	P	764328	618		• VALVE, Top	1
	P	764328	619		• VALVE, Bottom	1
	P	764322	052		• SEAL, Teflon Hyplon (ea.)	A/R
	P	764326	231		• SEAL, Teflon (Set of 2)	A/R
	P	764326	296		• VALVE, Drain	1
	P	764326	361		• WASHER, Stainless Steel	2
	P	764328	202		• REPAIR KIT	A/R

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FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-11-	(continued)				**Water-level Sight Glass Assembly .....**	X
6	*				KITS, Sight Glass	A/R
					Each kit contains two glasses and eight washers, four of P-751847-091 for round type, and two sets of P-764326-231 for square type valve bodies:	
	P	764321	544		• 4-11/16"	
	P	764323	880		• 5-1/2"	
	P	200000	081		• 5-7/8"	
	P	764324	699		• 6"	
	P	764321	195		• 6-1/4"	
	P	764323	543		• 6-1/2"	
	P	200000	136		• 6-5/8"	
	P	764328	920		• 6-3/4"	
	P	764324	885		• 7"	
	P	764323	948		• 7-1/4"	
	P	764322	879		• 7-1/2"	
	P	764323	456		• 7-3/4"	
	P	754031	091		• 8"	
	P	764324	697		• 8-1/2"	
	P	764324	700		• 9"	
	P	764325	491		• 9-1/8"	
	P	764321	717		• 9-1/2"	
	P	764323	457		• 9-3/4"	
	P	754032	091		• 10"	
	P	764323	458		• 10-1/4"	
	P	764329	913		• 10-1/2"	
	P	764321	716		• 10-3/4"	
	P	764324	701		• 11"	
	P	764325	492		• 11-1/8"	
	P	764325	698		• 11-1/2"	
	P	75424	091		• 12"	
	P	764325	493		• 13-1/8"	
					** To determine the correct length of the sight glass, measure the distance between the centerline of the upper and lower sight glass valve hand wheels and subtract either 1-1/4" (for the valve bodies that have a round-shaped casting) or 2" (for valve bodies that have a square-shaped casting).*	

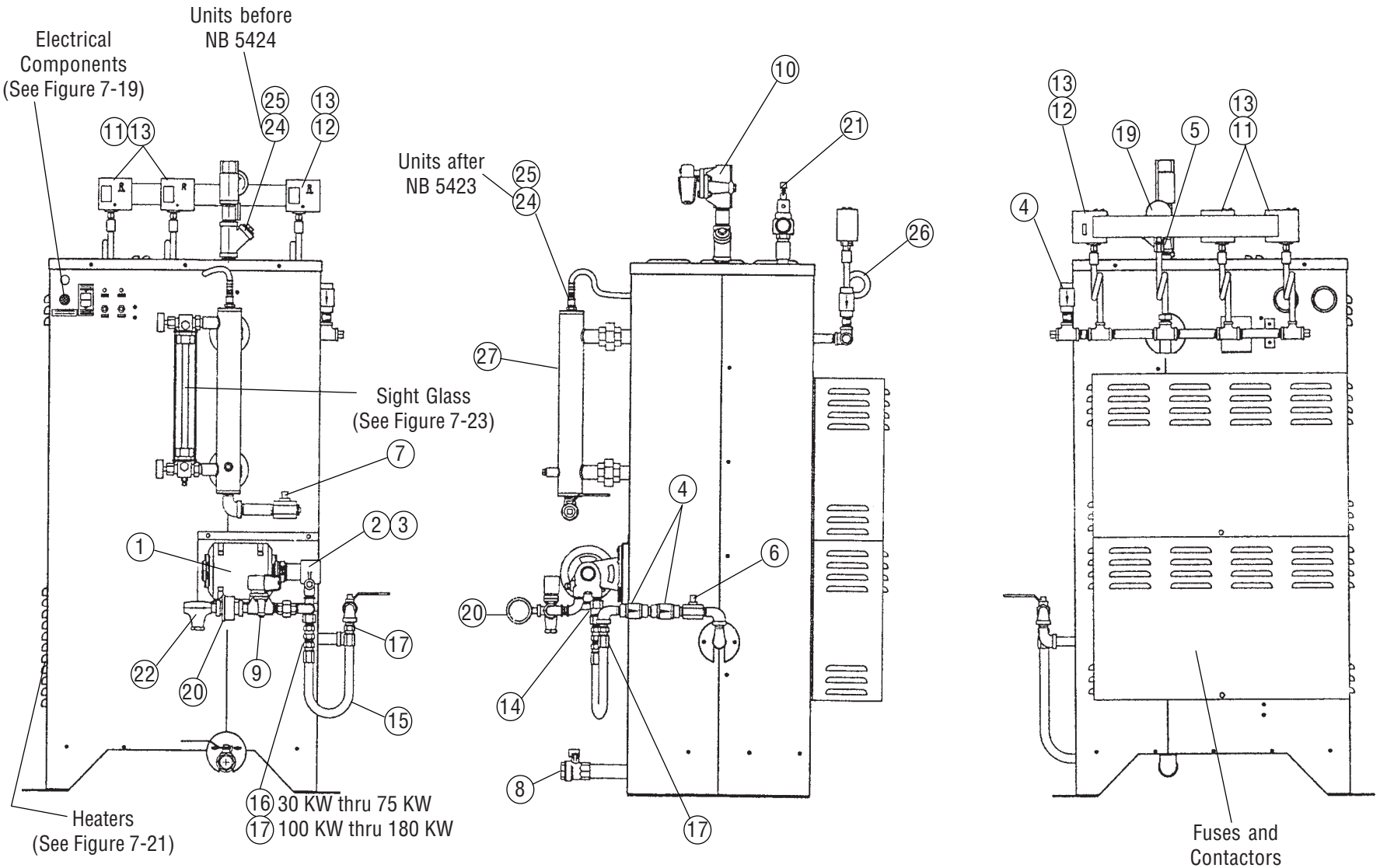
Electrical Components (See Figure 7-19)
Units before NB 5424
Units after NB 5423
Sight Glass (See Figure 7-23)
Heaters (See Figure 7-21)
16 30 KW thru 75 KW
17 100 KW thru 180 KW
Fuses and Contactors (See Figure 7-22)

Figure 7-12. CES (Stand-alone) Series Generator (Carbon Steel)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-12-					CES Series, Carbon Steel - 30 KW through 75 KW (CH05 through CH08)	X			
					CES Series, Carbon Steel - 100 KW through 180 KW (CH10 through CH14)		X		
1	P	764323	489		MOTOR, 115/230 V 1/3 HP	1			
	P	764326	373		MOTOR, 115/230 V 1/2 HP		1		
2	P	764319	902		PUMP (1.7 GPM)	1			
	P	764323	486		PUMP (3.2 GPM)		1		
3	P	764323	491		CLAMP, Pump	1	1		
4	P	764320	492		VALVE, Check 1/2" (also vac. breaker)	3	3		
5	P	764326	576		VALVE, Ball 1/4"	1	1		
6	P	764328	230		VALVE, Ball 1/2"	1	1		
7	P	764316	938		VALVE, Ball 3/4"	1	1		
8	P	910006	174		VALVE, Ball 1" (before date code 181PP)	1	1		
	P	764329	963		VALVE, Rising Stem Gate 1" (after date code 180PP)	1	1		
9	P	764323	319		VALVE, Solenoid 1/2" (Water)	1	1		
	P	764323	599		• KIT, Repair	1	1		
10	P	101006	806		VALVE, Solenoid 3/4" (Steam Outlet)	1			
	P	764324	417		• KIT, Repair	1			
	P	764076	002		• COIL	1			
	P	764323	703		VALVE, Solenoid 1" (Steam Outlet)		1		
	P	117951	000		• KIT, Repair		1		
	P	764324	557		• COIL		1		
11	P	764323	470		CONTROL, Pressure (Operating)	1	2		
12	P	764323	471		CONTROL, Pressure (High-Limit)	1	1		
13	P	764326	360		FITTING, Special	2	3		
14	P	46996	091		VALVE, Flow Control (2 GPM)	1			
	P	764326	193		VALVE, Flow Control (3.5 GPM)		1		
15	P	764323	493		HOSE	1	1		
16	P	764323	495		ADAPTER, Hose 3/8" NPT	1			
17	P	764323	496		ADAPTER, Hose 1/2" NPT	1	2		
18	P	764324	730		WELL, Probe (Not Shown)	1			
	P	764324	732		WELL, Probe (Not Shown)		1		
19	P	750467	091		GAUGE, Pressure	1	1		
20	P	764325	974		GAUGE, Pressure (Liquid-filled)	1	1		
21	P	764323	459		VALVE, Safety 100#	1			
	P	764323	460		VALVE, Safety 100#		1		
22	P	764323	482		STRAINER	1	1		
23	P	764328	318		ELECTRODE SET (Not Shown)	1			
	P	755716	257		• ELECTRODE, Water Level	1			
	P	755716	258		• ELECTRODE, Low Water Cut Off	1			
	P	755716	259		• ELECTRODE, Auxilliary Low Water Cut Off	1			
	P	764328	319		ELECTRODE SET (Not Shown)		1		
	P	755716	258		• ELECTRODE, Water Level		1		
	P	755716	260		• ELECTRODE, Low Water Cut Off		1		
	P	755716	261		• ELECTRODE, Auxilliary Low Water Cut Off		1		
24	P	764323	515		ELECTRODE, Anti-flood (before NB 5424)	1	1		
	P	764325	503		ELECTRODE, Anti-flood (after NB 5423)	1	1		
25	P	764326	926		BOOT, Electrode	4	4		
26	P	764323	476		TUBE, Siphon	3	4		
27	P	764326	237		SIDEARM	1			
	P	764326	238		SIDEARM		1		

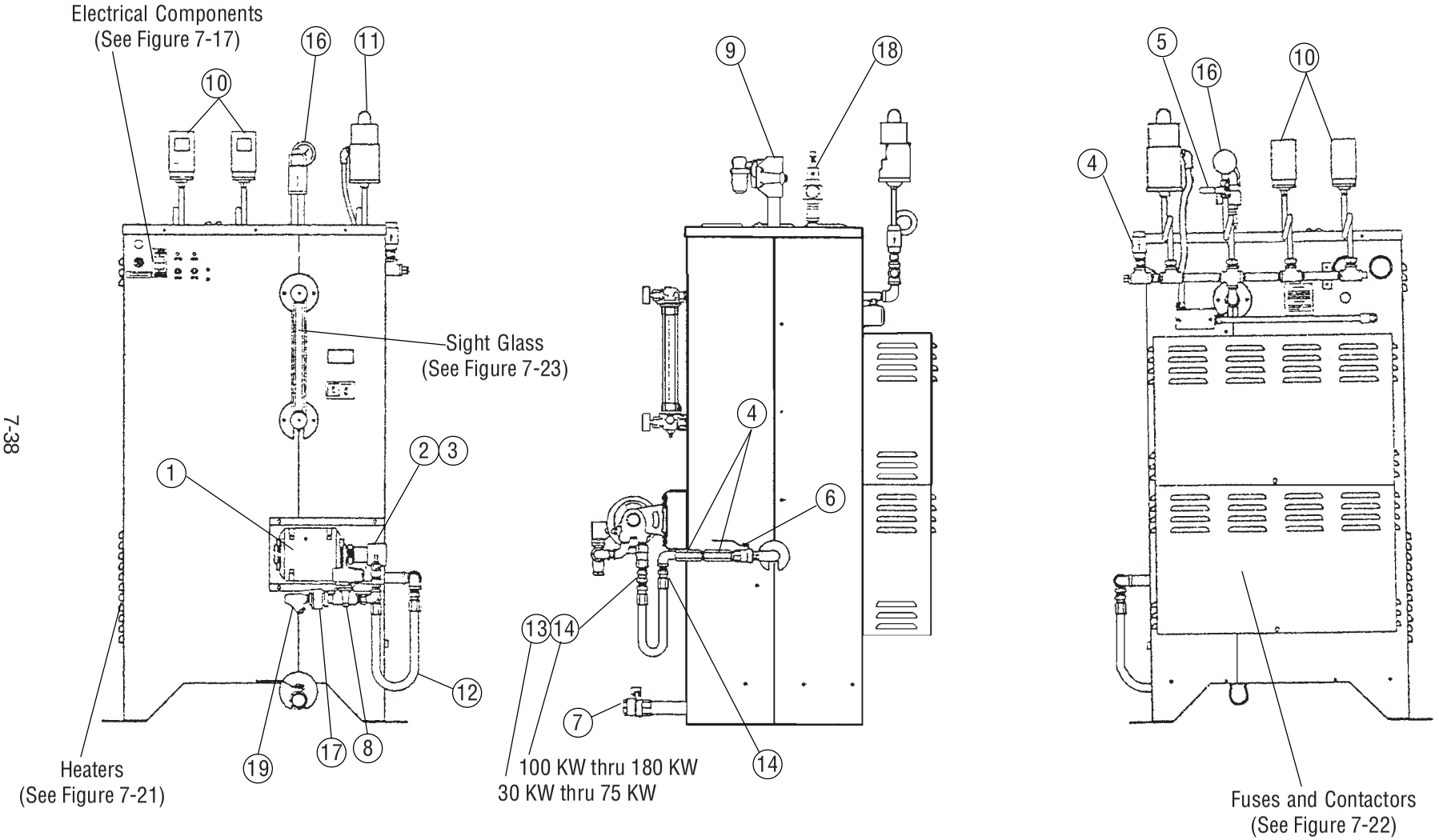

Figure 7-13. CES (Stand-alone) Series Generator (Stainless Steel)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-13-					CES Series, Stainless Steel - 30 KW through 75 KW (CH05 through CH08)	X			
					CES Series, Stainless Steel - 100 KW through 180 KW (CH10 through CH14)		X		
1	P	764323	489		MOTOR, 115/230 V 1/3 HP	1			
	P	764326	373		MOTOR, 115/230 V 1/2 HP		1		
2	P	764326	676		PUMP (1.7 GPM)	1			
	P	764326	135		PUMP (3.2 GPM)		1		
3	P	764323	491		CLAMP, Pump	1	1		
4	P	764326	446		VALVE, Check (also vac. breaker)	3	3		
5	P	150829	439		VALVE, Ball 1/4"	1	1		
6	P	764324	696		VALVE, Ball 1/2"	1	1		
7	P	764326	585		VALVE, Ball 1" (before date code 181PP)	1	1		
	P	764330	185		VALVE, Rising Stem Gate 1" (after date code 180PP)	1	1		
8	P	764326	116		VALVE, Solenoid 1/2" (Water)	1	1		
	P	764320	925		• KIT, Repair	1	1		
	P	910009	027		• COIL	1	1		
9	P	617100	767		VALVE, Solenoid 3/4" (Steam Outlet)	1			
	P	764324	147		• KIT, Repair	1			
	P	338517	158		VALVE, Solenoid 1" Steam Outlet		1		
	P	764326	889		• KIT, Repair		1		
	P	764076	002		• COIL		1		
10	P	764324	736		CONTROL, Pressure (Operating)	1	2		
11	P	764324	736		CONTROL, Pressure (High-Limit)	1	1		
12	P	764326	586		HOSE	1	1		
13	P	764326	816		ADAPTER, Hose 3/8" NPT	1			
14	P	764326	817		ADAPTER, Hose 1/2" NPT	1	2		
15	P	764324	726		WELL, Float (not shown)	1			
	P	764324	728		WELL, Float (not shown)		1		
16	P	764324	695		GAUGE, Pressure	1	1		
17	P	764325	975		GAUGE, Pressure (Liquid-filled)	1	1		
18	P	764316	742		VALVE, Safety 100#	1			
	P	764326	146		VALVE, Safety 100#		1		
19	P	386344	061		STRAINER	1	1		
20	P	764328	053		FLOAT, Level Control (8-wire, Not Shown)	1			
	P	764328	052		FLOAT, Level Control (8-wire, Not Shown)		1		
	P	764328	056		FLOAT, Level Control (2-wire, Not Shown)	1			
	P	764328	055		FLOAT, Level Control (2-wire, Not Shown)		1		

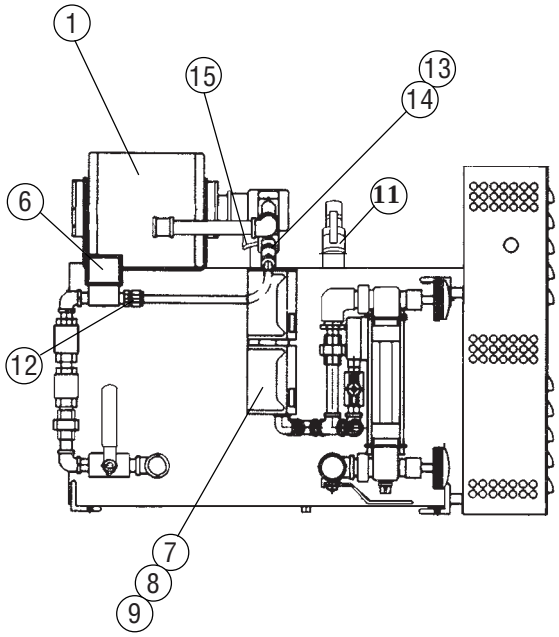

Figure 7-14a. Medallion/Eagle 2000 (20 KW)

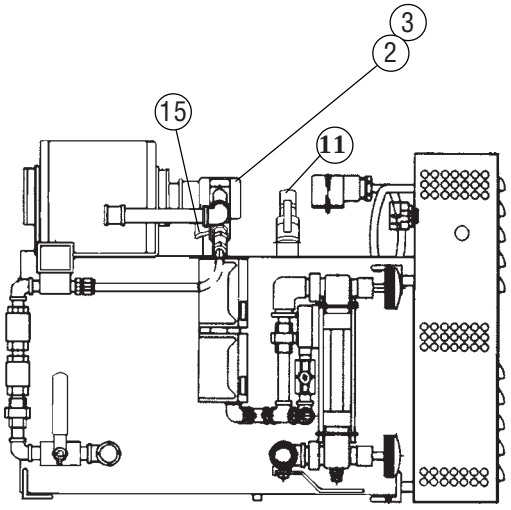

Figure 7-14c. Eagle 3000 Stage 3 (30 KW)

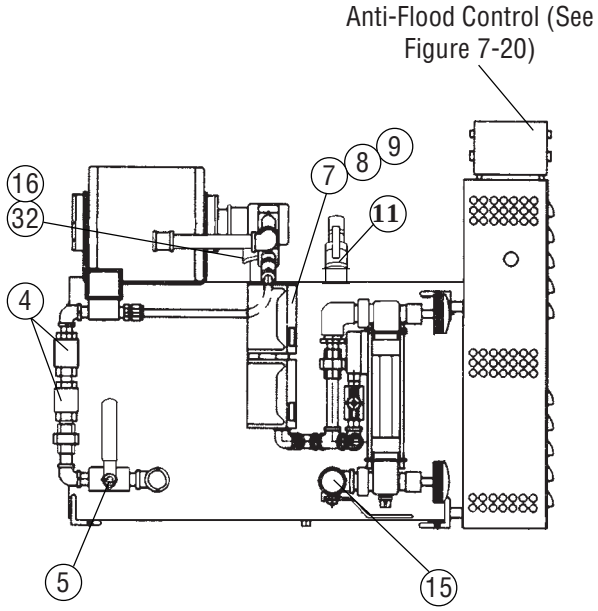

Figure 7-14b. Eagle 3000 Stage 2 (30 KW)

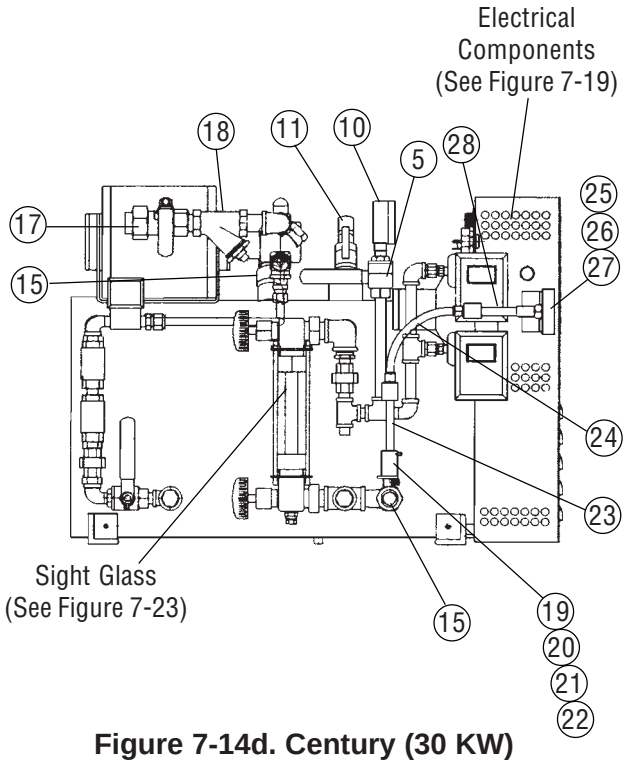

Figure 7-14d. Century (30 KW)

Figure 7-14. CHS/AS (Integral) Series (Carbon Steel)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-14-					CHS/AS Series: (Medallion/Eagle 2000) 20 KW	X			
					CHS/AS Series: (Eagle 3000 Stage 2) 30 KW	X			
					CHS/AS Series: (Eagle 3000 Stage 3) 30 KW		X		
					CHS/AS Series: (Century) 30 KW				X
1	P	764323	487		MOTOR, 115/230 V 1/4 HP	1	1	1	1
2	P	764323	551		PUMP	1	1	1	1
3	P	764323	491		CLAMP, Pump	1	1	1	1
4	P	764321	287		VALVE, Check 1/4"	2	2	2	2
5	P	764326	576		VALVE, Ball 1/4"	1	1	1	1
6	P	764323	548		VALVE, Solenoid 1/4" (Water)	1	1	1	1
	P	764323	595		• KIT, Repair	1	1	1	1
7	P	764323	471		CONTROL, Pressure, High-limit	1	1	1	1
8	P	764323	470		CONTROL, Pressure, Operating	1	1	1	1
9	P	764326	360		FITTING, Special	2	2	2	2
10	P	750467	091		GAUGE, Pressure	1	1	1	1
11	P	764323	459		VALVE, Safety	1	1	1	1
12	P	46365	091		FITTING, 1/4" NPT x 3/8" OD	1	1	1	1
13	P	78293	091		FITTING, 3/8" NPT x 3/8" OD	1	1	1	1
14	P	49337	091		VALVE, Flo Control	1	1	1	1
15	P	764328	230		VALVE, Ball 1/2" (before date code 181PP)	2	1	2	2
	P	764329	962		VALVE, Rising Stem Gate 1/2" (after date code 180PP)	2	1	2	2
16	P	764323	515		ELECTRODE, Spark Plug		1		
17	P	93910	480		VALVE, Union Ball 1/2"				1
18	P	129357	906		STRAINER 1/2"				1
19	P	755716	867		ADAPTER (after date code 180PP)				1
	P	52309	045		ADAPTER (before date code 181PP)				1
20	P	10583	091		SCREW, Set				2
21	P	46038	061		PIN, Cotter				1
22	P	150828	377		STOP, Valve (before date code 181PP)				1
23	P	764326	674		EXTENSION, Valve Rod (before date code 181PP)				1
24	P	089881	045		SHAFT, Flexible				1
25	P	8605	042		NUT, Handwheel				1
26	P	54899	091		HANDWHEEL				1
27	P	90833	091		DECAL				1
28	P	764326	675		EXTENSION, Valve Rod				1
29	P	755716	254		PROBE, Water Level (not shown)	1	1	1	1
30	P	764326	926		BOAT, Electrode (not shown)	2	3	2	2
31	P	755716	255		PROBE, Low Water Cut-off (not shown)	1	1	1	1
32	P	101006	805		VALVE, Solenoid 1/2" (steam) (not shown)		1		
	P	764324	556		• REPAIR KIT		1		
	P	764076	002		• COIL		1		
33	P	764323	325		TUBE, Isolator (not shown)	1	1	1	1
34	R	004018	380		CABLE, Wire (3 Cond) (Noit Shown)	A/R	A/R	A/R	A/R

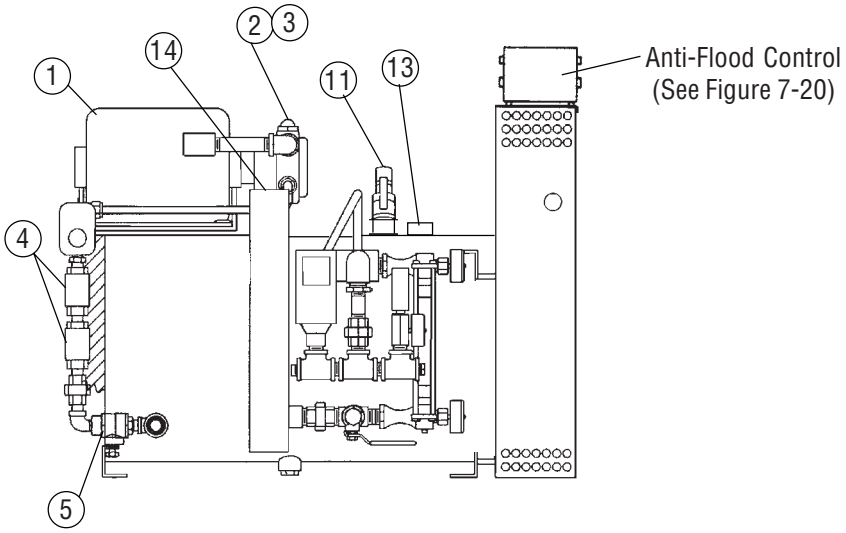

Figure 7-15a. Eagle 3000 Stage 2 (30 KW)

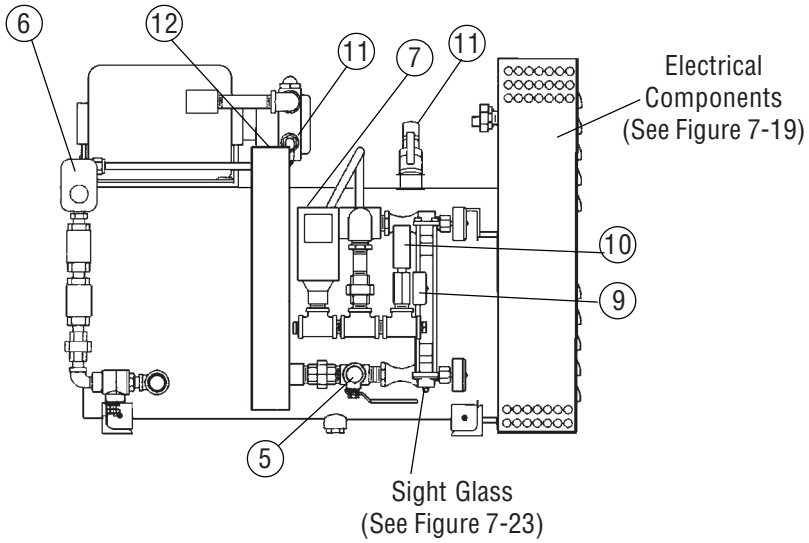

**Figure 7-15b. Medallion/Eagle 2000 (20 KW)/
Eagle 3000 Stage 3/Century (30 KW)**

Figure 7-15. CHS/AS/SST (Integral) Series (Stainless Steel)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-15-					CHS/AS Series: (Stainless Steel) (Eagle 3000 Stage 2 [30 KW])	X			
					CHS/AS Series: (Stainless Steel) (Medallion/Eagle 2000 [20 KW]/Eagle 3000 Stage 3/ Century [30 KW])		X		
1	P	764323	487		MOTOR, 115/230 V 1/4 HP	1	1		
2	P	764324	674		PUMP	1	1		
3	P	764323	491		CLAMP PUMP	1	1		
4	P	764326	446		VALVE, Check 1/2"	1	1		
5	P	764324	696		VALVE, Ball 1/2" (before date code 181PP)	2	3		
	P	764330	184		VALVE, Rising Stem Gate 1/2" (after date code 180PP)	1	2		
6	P	764324	670		VALVE, Solenoid 1/4" (water)	1	1		
	P	764324	672		• Repair Kit	1	1		
	P	910009	026		• Coil	1	1		
7	P	764324	673		Control Pressure (Operating/Hi Limit)	1	1		
8	P	617100	766		VALVE, Solenoid 1/2" (steam) (not shown)	1			
	P	764324	147		• Repair Kit	1			
9	P	150829	439		VALVE, Ball 1/4"	1	1		
10	P	764324	695		GAUGE, Pressure	1	1		
11	P	764316	742		VALVE, Safety	1	1		
12	P	764328	057		CONTROL, Float Level (4 wire)		1		
13	P	764328	063		CONTROL, Float Level (2 wire)	1			
14	P	764328	064		CONTROL, Float Level (4 wire)	1			
15	P	764324	734		TUBE, Isolator	1			
16	R	004018	380		CABLE, Wire (3 Cond) (Not Shown)	A/R			

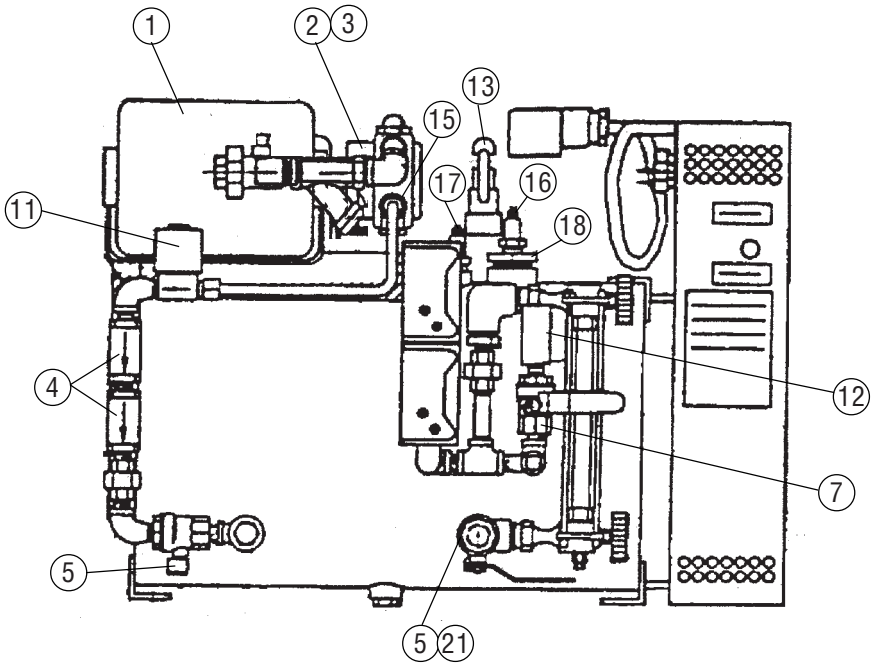

Figure 7-16a. Carbon Steel (45 KW)

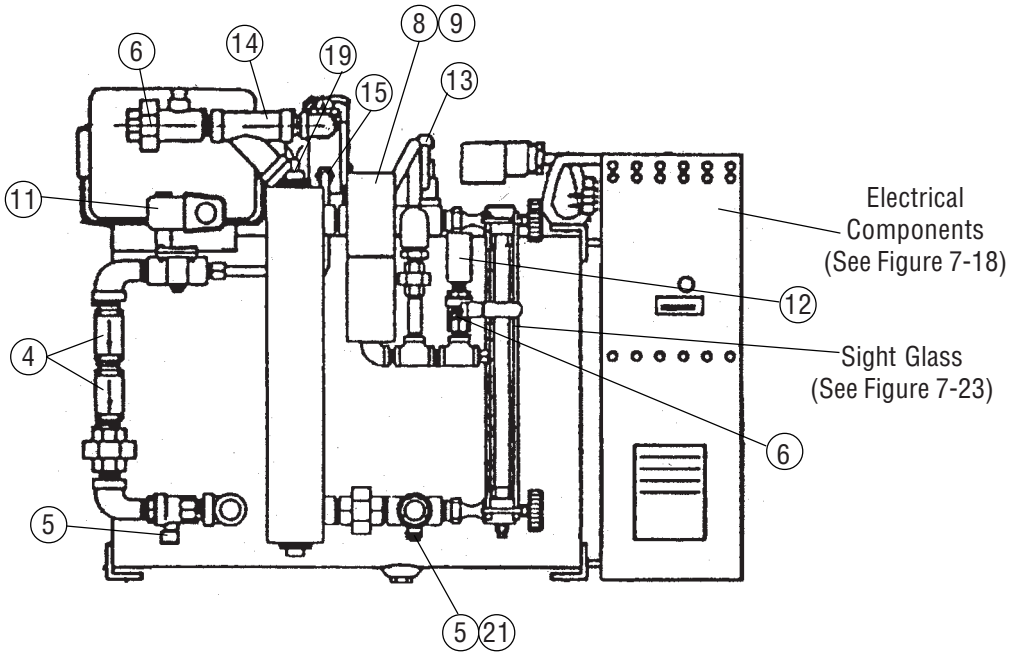

Figure 7-16b. Carbon Steel or Stainless Steel with Float Control

Figure 7-16. CHS/AS Series - 45 KW
(Carbon Steel and Stainless Steel)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-16-					CHS/AS Series: - 45 KW	X			
					CHS/AS Series: with float control - 45 KW		X		
					CHS/AS/SST Series: - 45 KW (Stainless Steel)		X		
1	P	764323	489		MOTOR, 115/230 V 1/3 HP	1	1	1	
2	P	764319	902		PUMP	1	1		
	P	764326	676		PUMP			1	
3	P	764323	491		CLAMP PUMP	1	1	1	
4	P	764320	492		VALVE, Check 1/2"	1	1		
	P	764326	446		VALVE, Check 1/2"			1	
5	P	764328	230		VALVE, Ball 1/2" (after date code 180PP)*	1	1		
	P	764324	696		VALVE, Ball 1/2" (after date code 180PP)*			1	
6	P	93910	480		VALVE, Union Ball 1/2"	1	1		
7	P	764326	576		VALVE, Ball 1/4"	1	1		
	P	150829	439		VALVE, Ball 1/4"			1	
8	P	764323	470		CONTROL PRESSURE (Operating)	1	1		
	P	764324	673		CONTROL PRESSURE (Operating/Hi-Limit)			1	
9	P	764323	471		CONTROL PRESSURE (Hi-Limit)	1	1		
10	P	764326	360		FTG., Special	2	2		
11	P	764323	319		VALVE, Solenoid (Water) 1/2"	1	1		
	P	764323	599		• Repair Kit	1	1		
	P	764326	116		VALVE, Solenoid (Water) 1/2"			1	
	P	764320	925		• Repair Kit			1	
	P	910009	027		• Coil			1	
12	P	750467	091		GAUGE, Pressure (0-160 PSI)	1	1		
	P	764324	695		GAUGE, Pressure (0-160 PSI)			1	
13	P	764323	459		VALVE, Safety	1	1		
	P	764316	742		VALVE, Safety			1	
14	P	129357	906		STRAINER	1	1		
	P	764320	891		• Screen	1	1		
	P	764326	727		• o-ring	1	1		
15	P	764326	372		VALVE, Flo Control (2 GPM)	1	1		
16	P	755716	531		ELECTRODE, Water Level	1			
17	P	755716	256		ELECTRODE, Low Water Cutoff	1			
18	P	764329	029		TUBE, Isolator	1			
19	P	764328	057		CONTROL, Float Level (4 wire)		1	1	
20	P	764326	926		BOAT, Electrode (not shown)	2			
21	P	764329	962		VALVE, Rising Stem Gate 1/2" (after date code 180PP)	2	2		
	P	764330	184		VALVE, Rising Stem Gate 1/2" (after date code 180PP)			2	

* *For units before date code 181PP, there are three (3) units per assembly.*

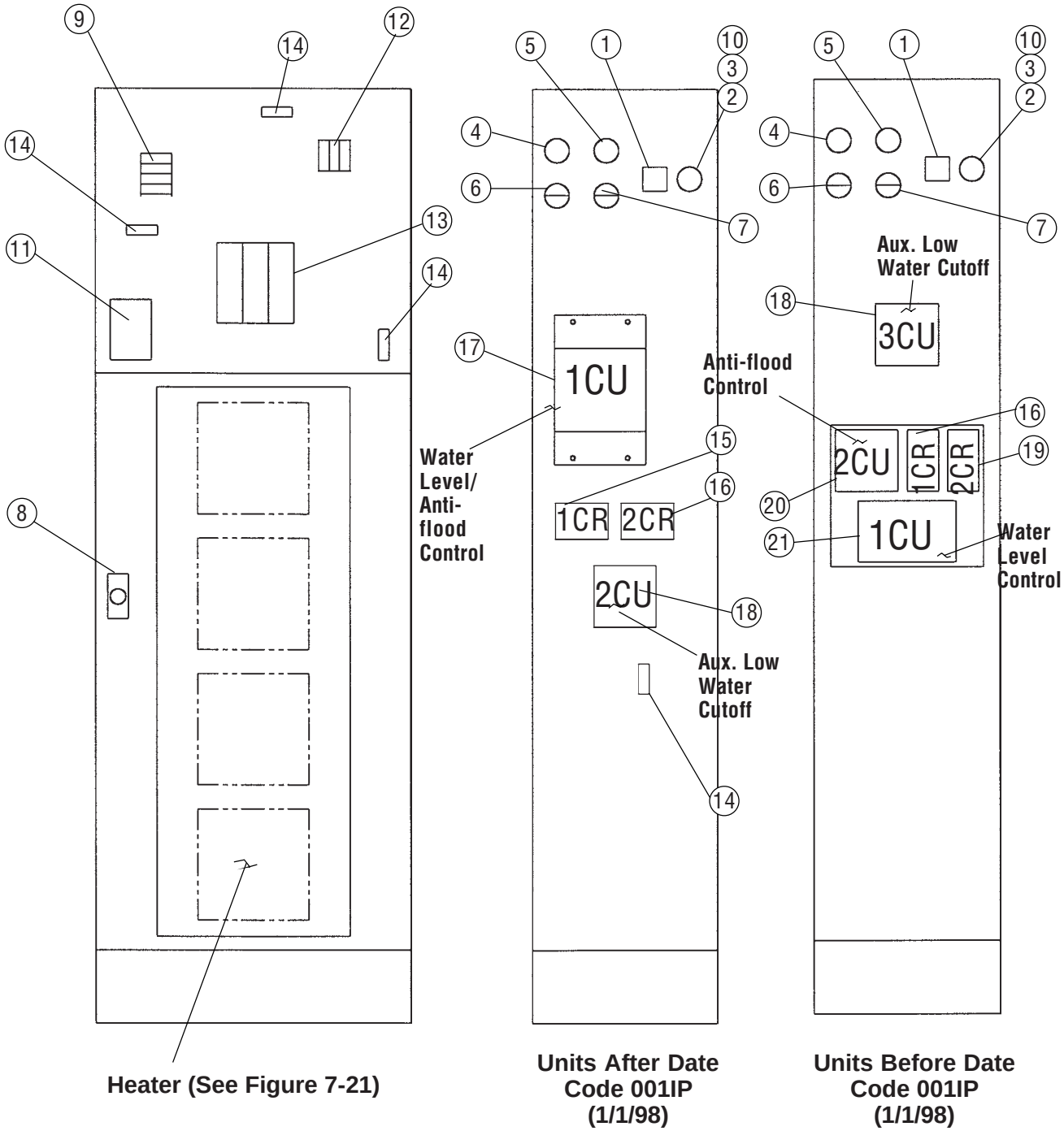

Figure 7-17. CES SERIES ELECTRICAL COMPONENTS

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-17-					CES Series Electrical Components	X
1	P	764323	522		SWITCH, On-Off	1
2	P	764323	523		FUSE, 15A (Box of 5)	1
3	P	764323	525		HOLDER, Fuse	1
4	P	764323	328		LIGHT, Pilot (Amber)	1
5	P	764323	329		LIGHT, Pilot (Green)	1
6	P	764323	326		SWITCH, Pushbutton (MOM/N.C.)	1
7	P	78481	091		SWITCH, Pushbutton (MOM/N.O.) after date code 001IP	1
8	P	764325	508		SWITCH, Door Interlock	1
9	P	764323	538		BLOCK, Terminal (4 POLE) 110V	1
10	P	764317	837		FUSE, 1/4A (Box of 5) 380/415 V Units Only	1
11	P	764326	132		TRANSFORMER, 220/480 V - 120V	1
	P	764326	874		• FUSE, .6A (Box of 5)	2
12	P	90746	091		BLOCK, Terminal (3 POLE) 110V	1
13	P	764323	445		BLOCK, Terminal, 115 A (1 line, 1 load circuits)	A/R
	P	764323	446		BLOCK, Terminal, 175 A (1 line, 4 load circuits)	A/R
	P	764323	447		BLOCK, Terminal, 335 A (1 line, 4 load circuits)	A/R
	P	764323	448		BLOCK, Terminal, 335 A (1 line, 8 load circuits)	A/R
14	P	764323	333		LUG, Grounding	3
15	P	764326	233		CONTACTOR, Lovato	1
16	P	764323	553	*	RELAY, Plug-in, Anti-flood	1
17	P	764326	194		BOARD, Control (Water-level, Anti-flood)	1
18	P	764325	530		BOARD, Control (Aux. Low Water Cut-off)	1
19	P	764323	557	*	RELAY, Control (2CR)	1
20	P	764323	552	*	BOARD, Control (Anti-flood)	1
21	P	764329	567	*	BOARD, Control, (Water-level) CURTIS	1
	P	764322	763		• RELAY	1
	P	764328	355	*	BOARD, Control (Water-level) WARRICK	1
	P	764328	068		• KIT, Relay	1
	P	764326	233		• CONTACTOR (LAVATO)	1
22	P	41293	091		RELAY, Heavy Duty (units with 220 V pump motor) (not shown)	1

**Units before date code 001IP only (1/1/98)*

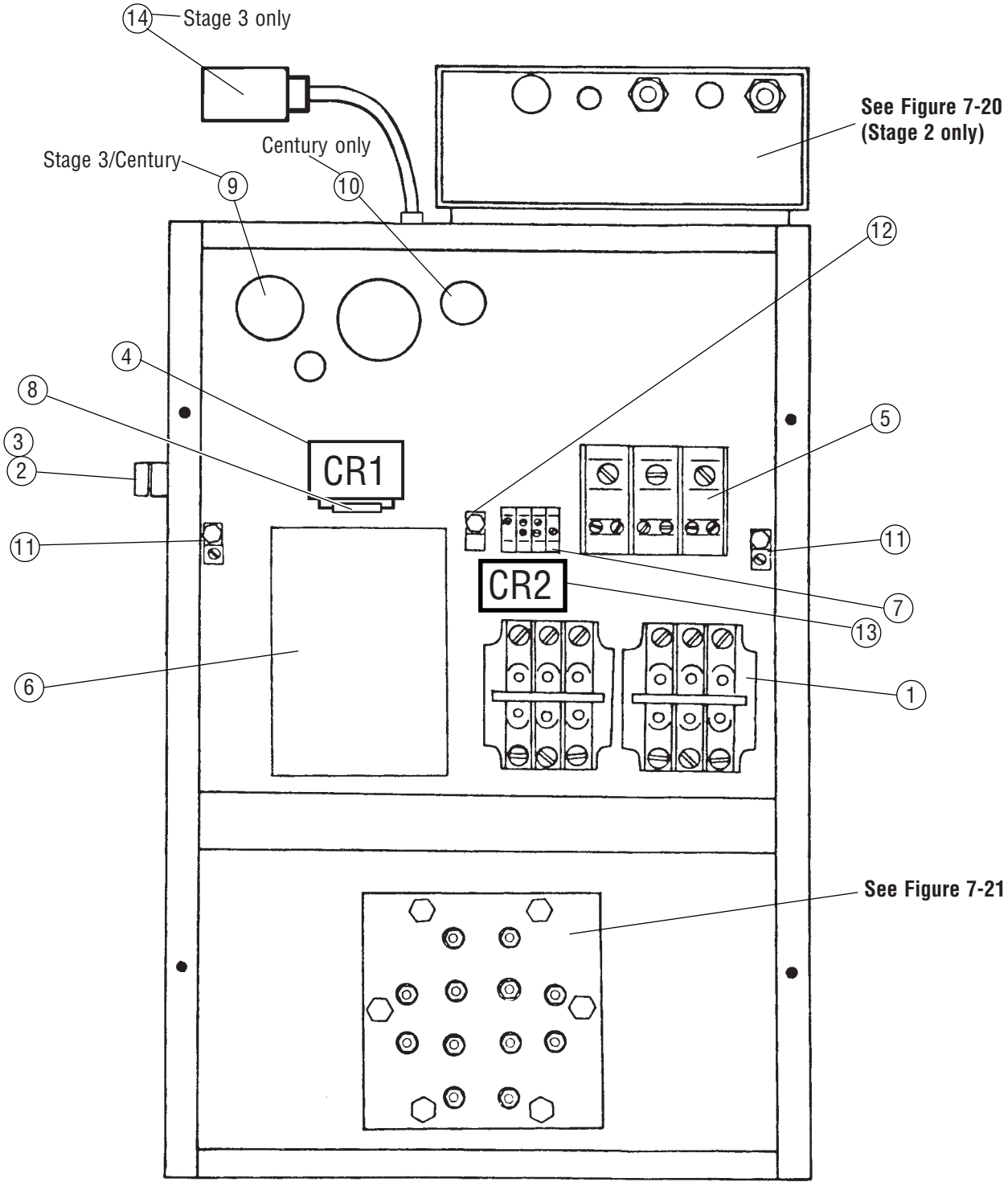

Figure 7-18. CHS/AS SERIES ELECTRICAL COMPONENTS (20/30 KW)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-18-					CHS/AS Electrical Components (Century)	X			
					CHS/AS Electrical Components (Eagle 3000 Stage 3)		X		
					CHS/AS Electrical Components (Medallion/Eagle 2000/ Eagle 3000 Stage 2)			X	
1	P	759747	001		CONTACTOR, 50 A	A/R	A/R	A/R	
	P	759746	001		CONTACTOR, 40 A			A/R	
2	P	764323	525		FUSE, Holder	1	1	1	
3	P	764323	556		FUSE, 10 Amp (Box of 5)	1	1	1	
4	P	764323	557		RELAY, Control (CR1)	1	1	1	
5	P	764323	446		BLOCK, Terminal (3 PH) 208/240 V	1	1	1	
	P	764323	641		BLOCK, Terminal (3 PH) 480 V, Only	3	3	3	
	P	764323	640		END, Terminal Block (3 PH), 480 V, Only	1	1	1	
6	P	764323	558	**	CONTROL, Water-level and Low-water				
		764329	567		Cut-off (CURTIS, before date code 245 LP) (8/2/96)			1	
	P	764322	763		• RELAY, Pump Motor			1	
	P	764328	355	**	CONTROL, Water-level and Low-water				
					Cut-off (WARRICK, before date code 245 LP) (8/2/96)	1	1	1	
	P	764328	068		• RELAY, Pump Motor	1	1	1	
	P	764328	355		CONTROL, Water-level and Low-water Cut-off				
					(After date code 245 LP) (8/2/96)	1	1	1	
	P	764326	233		• CONTACTOR, Pump Motor	1	1	1	
7	P	150461	001		BLOCK, Terminal (1 PH)	1	1	1	
8	P	764323	341		RESISTOR	1	1	1	
9	P	764325	684		CONNECTOR (AUS Century) (S09 Stage 3)	1	1		
10	P	93909	232		CONNECTOR (P100)	1			
11	P	764323	333		LUG, Grounding	2	2	2	
12	P	764323	332		LUG, Grounding	1	1	1	
13	P	41293	091	*	RELAY, (2CR)	1	1	1	
14	P	755716	068		CONNECTOR (S09A)		1		

** For 380/415 V units, only.*

*** Identify board manufacturer prior to ordering.*

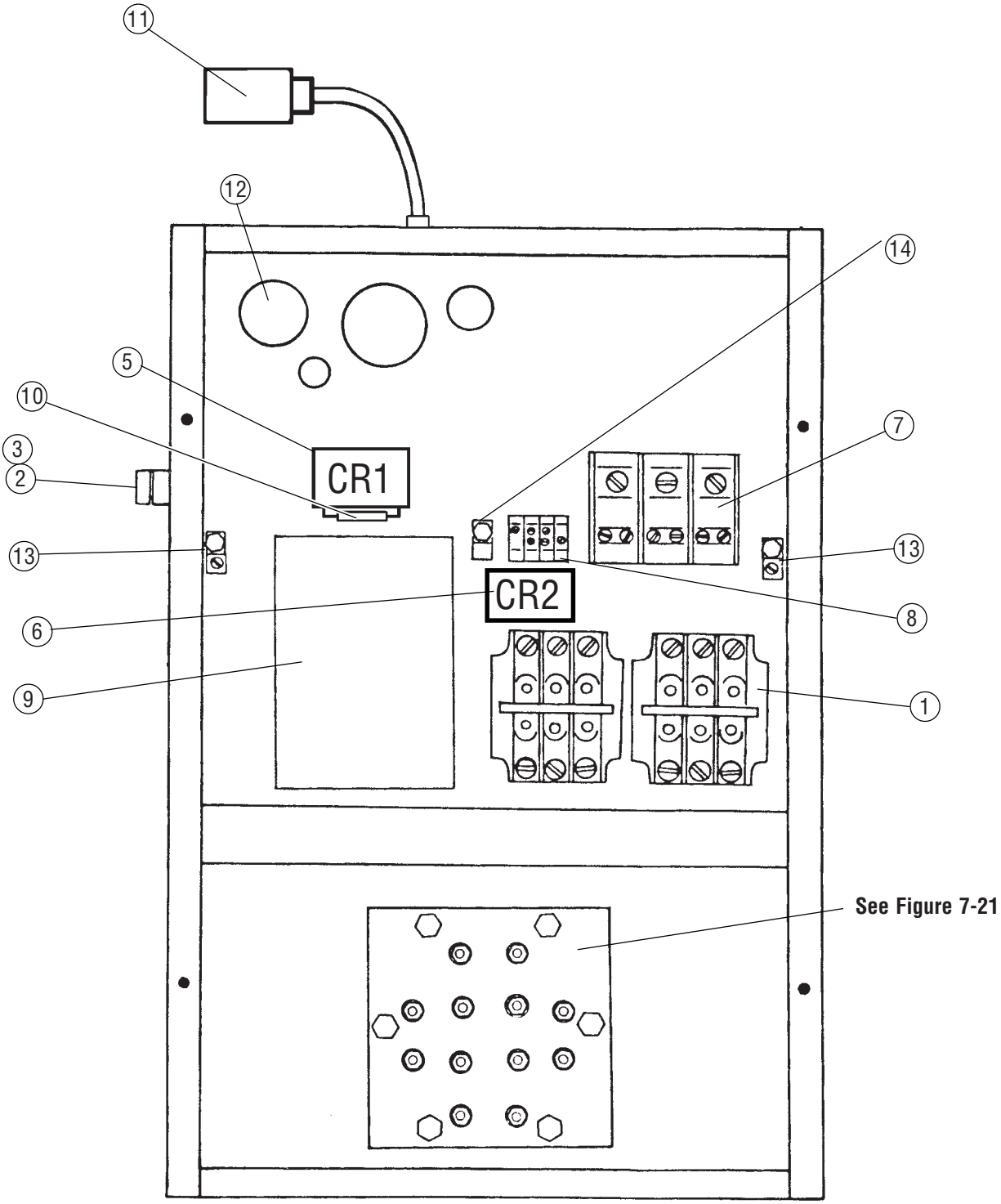

Figure 7-19. CHS/AS SERIES ELECTRICAL COMPONENTS (45 KW)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-19-					CHS/AS Electrical Components	X
1	P	759747	001		CONTACTOR, 50 Amp (380 V)	2
	P	759748	001		CONTACTOR, 60 Amp (480 V)	1
	P	764323	694		CONTACTOR, 75 Amp (208/240 V)	2
2	P	764323	525		FUSE, Holder	1
3	P	764323	556		FUSE, 10 Amp (Box of 5)	1
4	P	764325	571		FUSE, 80 Amp (208 V/240 V only) (not shown)	6
5	P	764323	557		RELAY, Control (CR1)	1
6	P	764326	233	*	RELAY (CR2)	1
7	P	764323	446		BLOCK, Terminal (3PH)	1
8	P	150461	001		BLOCK, Terminal, Control Circuit	1
9	P	764324	884		Control - Water Level and Low Water Cut-off (Warrick before date code 245LP) (8/2/96)	1
	P	764328	068		• RELAY, Pump Motor	1
	P	764328	355		Control - Water Level and Low Water Cut-off (Warrick after date code 245LP) (8/2/96)	1
	P	764326	233		• CONTACTOR, Pump Motor	1
10	P	764323	341		RESISTOR	1
11	P	755716	068		CONNECTOR (S09A)	1
12	P	764325	684		CONNECTOR (S09)	1
13	P	764323	333		LUG, Grounding	2
14	P	764323	332		LUG, Grounding	1

* *For 380/415 V units, only.*

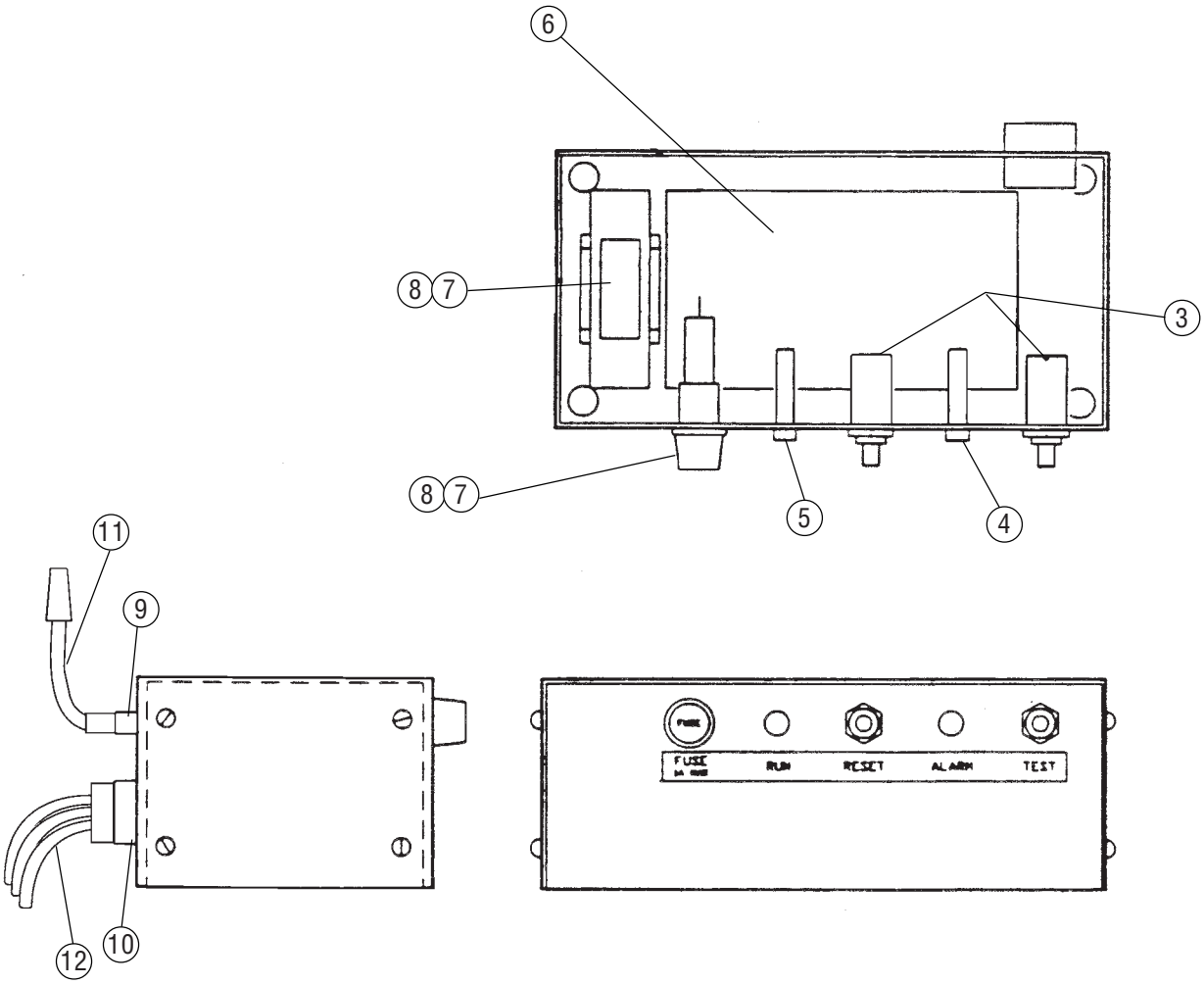

Figure 7-20. ANTI-FLOOD CONTROL, CHS/AS SERIES (EAGLE 3000 STAGE 2 ONLY)

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-20-	P	764323	321		ANTI-FLOOD CONTROL, CHS Series	X
1	P	764323	525		FUSE HOLDER	1
2	P	764323	554		FUSE, .8 Amp.	1
3	P	764323	326		SWITCH, Momentary Contact NC	2
4	P	764323	328		PILOT LIGHT-- Amber	1
5	P	764323	329		PILOT LIGHT-- Green	1
6	P	764323	552	*	CONTROL BOARD	1
7	P	764323	324		RELAY, Socket Base	1
8	P	764323	553		RELAY, IDEC	1
9	P	764323	323		HARNESS, Wire, 3 Position	1
10	P	764323	322		HARNESS, Wire, 9 Position	1
11	P	764327	653		HARNESS, Wire (J12)	1
12	P	764327	652		HARNESS, Wire (generator, pump valve, probe, etc.)	1

* *NOTE: Due to complexity of anti-flood control, replacement of the control board is not suggested. It is recommended the entire control be replaced if the board is found to be defective.*

SPECIFICATIONS

Catalog Number	KW	B.H.P. Rating	No. and KW of Heating Elements
CHS 20AS	20	2.0	1-20 KW
CHS 30AS	30	3.0	1-30 KW
CHS 45AS	45	4.6	1-45 KW
CH02	10	1.0	1-10 KW
CH03	15	1.5	1-15 KW
CH04	20	2.0	1-20 KW
CH05	30	3.0	1-30 KW
CH06	40	4.1	2-20 KW
CH07	60	6.1	2-30 KW
CH08	75	7.7	2-37.5 KW
CH10	102	10.4	3-34 KW
CH12	120	12.2	3-40 KW
CH13	150	15.3	4-37.5 KW
CH14	180	18.4	4-45 KW

(1)(3) (2)(4) (2)(4)

NOTE: 1. Sequentially torque all heater bolts 200^{+10}_{-0} in/lb

2. All heaters include heater gasket.

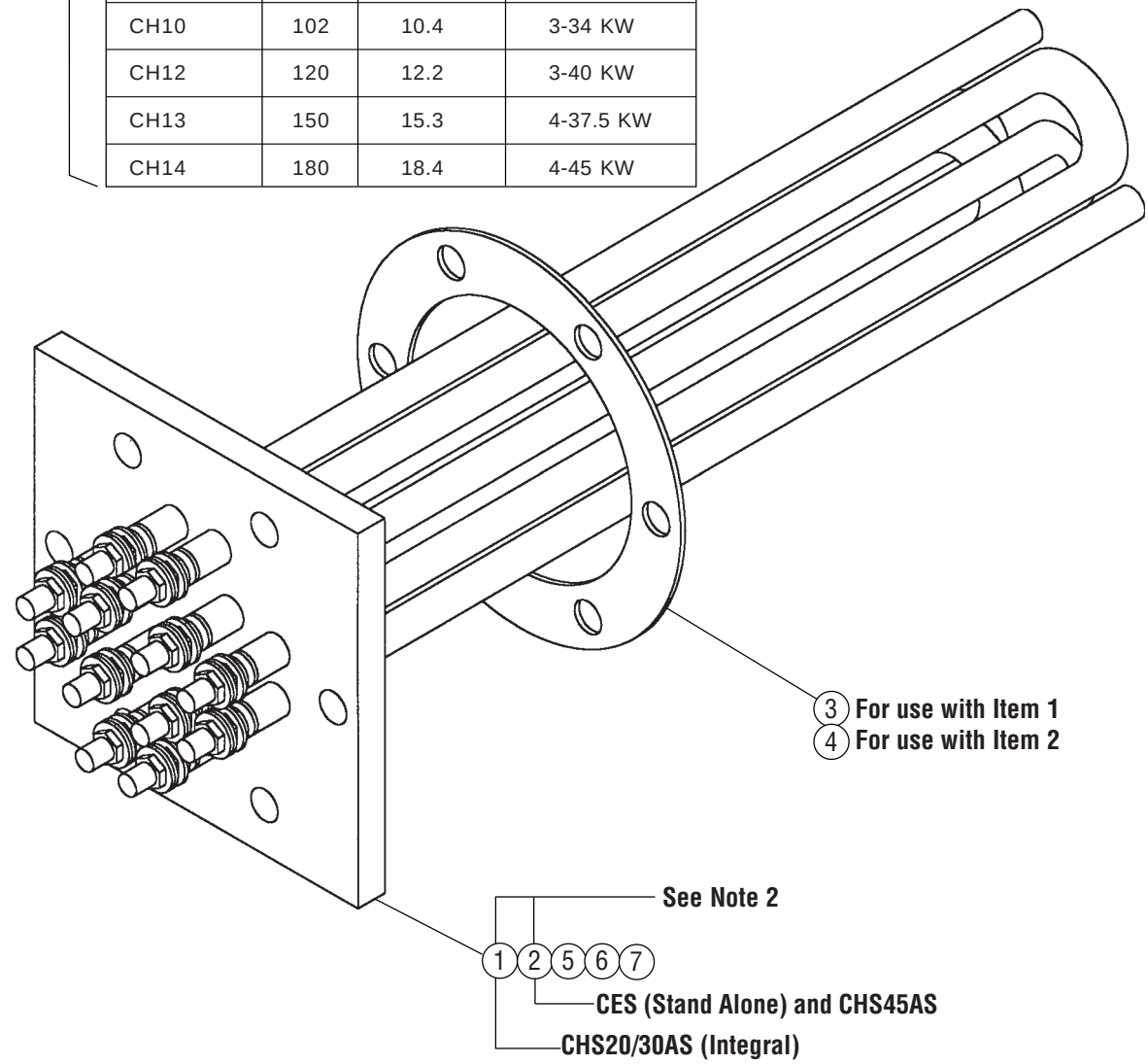

Figure 7-21. CES HEATER and CHS ELEMENTS

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-21-					CES and CHS HEATERS	
1	P	764325	727		HEATER, 20 KW (208/240 V)	
	P	764326	982		HEATER, 20 KW (380/415 V)	
	P	764325	726		HEATER, 20 KW (480 V)	
	P	764328	020		HEATER, 30 KW (208 V) (Century Only)	
	P	764328	094		HEATER, 30 KW (208 V) Stainless Steel (Century Only)	
	P	764323	549		HEATER, 30 KW (208/240 V)	
	P	764324	764		HEATER, 30 KW (208/240 V) Stainless Steel	
	P	764323	639		HEATER, 30 KW (380/415 V)	
	P	764327	659		HEATER, 30 KW (380/415 V) Stainless Steel	
	P	764323	550		HEATER, 30 KW (480 V)	
	P	764324	765		HEATER, 30 KW (480 V) Stainless Steel	
	P	764327	911		HEATER, 30 KW (575/600 V)	
2	P	764323	413	*	HEATER, 20 KW (208 V)	
	P	764324	886		HEATER, 20 KW (208 V)	
	P	764326	594	*	HEATER, 20 KW (208 V) Stainless Steel	
	P	764326	596		HEATER, 20 KW (208 V) Stainless Steel	
	P	764323	415	*	HEATER, 20 KW (240 V)	
	P	764323	424		HEATER, 20 KW (240 V)	
	P	764325	671		HEATER, 20 KW (240 V) Stainless Steel	
	P	764324	887		HEATER, 20 KW (380 V)	
	P	764323	417	*	HEATER, 20 KW (480 V)	
	P	764323	425		HEATER, 20 KW (480 V)	
	P	764323	418		HEATER, 30 KW (208 V)	
	P	764326	598		HEATER, 30 KW (208 V) Stainless Steel	
	P	764323	419		HEATER, 30 KW (240 V)	
	P	764326	753		HEATER, 30 KW (240 V) Stainless Steel	
	P	764325	448		HEATER, 30 KW (380 V)	
	P	764327	659		HEATER, 30 KW (380 V) Stainless Steel	
	P	764323	420		HEATER, 30 KW (480 V)	
	P	764326	754		HEATER, 30 KW (480 V)	
	P	764323	655		HEATER, 34 KW (208 V)	
	P	764323	657		HEATER, 34 KW (240 V)	
	P	764326	597		HEATER, 34 KW (240 V)	
	P	764324	731		HEATER, 34 KW (380 V)	
	P	764326	875		HEATER, 34 KW (415 V)	

* *For use with CH04 20 KW Generators Only*

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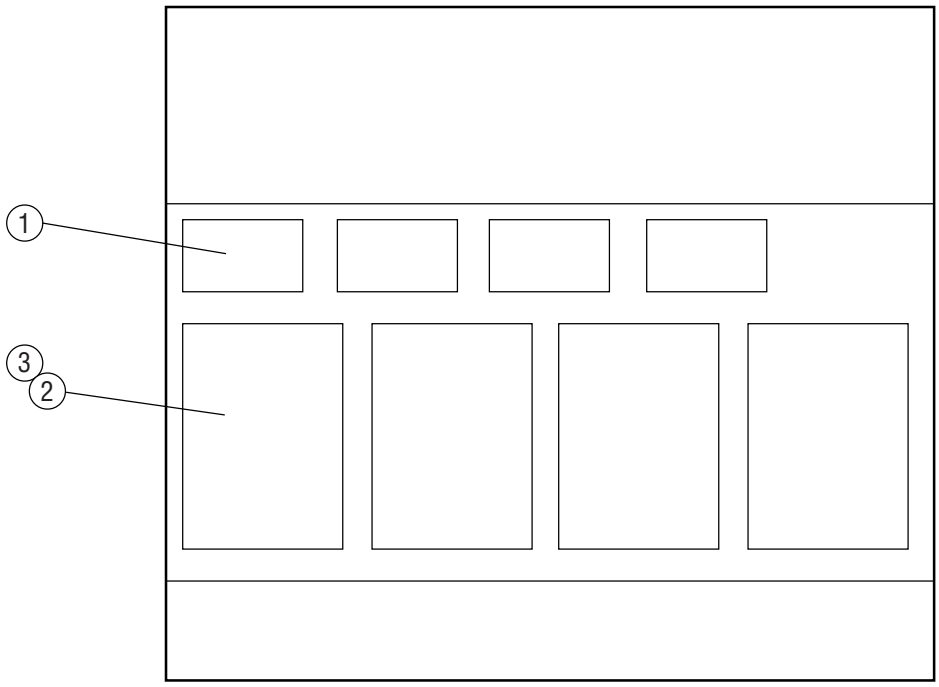
FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
7-21-					HEATERS (continued)				
	P	764323	691		HEATER, 34 KW (480 V)				
	P	764323	999		HEATER, 34 KW (480 V)				
	P	764329	304		HEATER, 34 KW (575/600 V)				
	P	764323	421		HEATER, 34 KW (208 V)				
	P	764323	422		HEATER, 37.5 KW (240 V)				
	P	764326	300		HEATER, 37.5 KW (240 V) Stainless Steel				
	P	764326	083		HEATER, 37.5 KW (380 V)				
	P	764328	077		HEATER, 37.5 KW (415 V)				
	P	764323	423		HEATER, 37.5 KW (480 V)				
	P	764326	364		HEATER, 37.5 KW (480 V) Stainless Steel				
	P	764324	889		HEATER, 37.5 KW (208 V)				
	P	764329	363		HEATER, 40 KW (208 V)				
	P	764325	065		HEATER, 40 KW (240 V)				
	P	764326	866		HEATER, 40 KW (380 V)				
	P	764326	867		HEATER, 40 KW (415 V)				
	P	764323	715		HEATER, 40 KW (480 V)				
	P	764326	595		HEATER, 40 KW (480 V) Stainless Steel				
	P	764326	541		HEATER, 45 KW (208 V)				
	P	764323	426		HEATER, 45 KW (240 V)				
	P	764328	076		HEATER, 45 KW (380 V)				
	P	764328	075		HEATER, 45 KW (415 V)				
	P	764323	427		HEATER, 45 KW (480 V)				
	P	764327	774		HEATER, 45 KW (480 V) Stainless Steel				
3	P	764323	527		GASKET, Heater (4-1/2" OD)				
4	P	764323	594		GASKET, Heater (5-1/2" OD)				
5	P	764323	643		BOLT, Heater (ea) 5/16 - 18x1				
	P	764323	643		BOLT, Heater (Box of 6)				
6	P	764326	679		WIRE, Heater/Contactor (#6) U/M: Feet				
	P	764326	680		WIRE, Heater/Contactor (#8) U/M: Feet				
	P	764326	681		WIRE, Heater/Contator (#10) U/M: Feet				
	P	764325	973	**	WIRE, Heater/Contactor (#10) U/M: Feet				
7	P	764326	885		TERMINAL, Wire (for #6 Wire)				
	P	764327	768		TERMINAL, Wire (for #8 Wire)				
	P	764326	920		TERMINAL, Wire (for #10 Wire)				
8	P	764325	699		FLANGE, Heater (Blind) (not shown)				
	P	764327	686		FLANGE, Heater (Blind), Stainless Steel (not shown)				

** *For use with all integral CHS20AS and CHS30AS units except CHS 45AS and 208V Century (for 208 V Century use #8 Wire, P-764328-680)*



SPECIFICATIONS			Three-Phase Voltages					
Catalog Number	KW (9.8 KW = 1 BHP)	B.H.P. Rating	Contactors Quantity and Rating			Fuses Quantity and Rating		
			208	240	480	208	240	480
CHS20AS	20	2.0	1-50	1-50	1-40	–	–	–
CHS30AS	30	3.0	2-50	2-50	1-50	–	–	–
CHS45AS	45	4.6	2-75	2-75	1-60	6-80	6-80	–
CH02	10	1.0	1-40	1-40	1-40	–	–	–
CH03	15	1.5	1-50	1-40	1-40	3-60	–	–
CH04	20	2.0	1-65	1-50	1-40	3-70	3-60	–
CH05	30	3.0	2-50	2-50	1-40	6-60	4-45	–
CH06	40	4.1	2-65	2-50	1-50	6-70	6-60	3-60
CH07	60	6.1	4-50	4-50	2-50	12-60	12-50	6-50
CH08	75	7.7	4-65	4-50	2-50	12-70	12-60	6-60
CH10	102	10.4	6-50	6-50	3-50	18-60	18-60	9-60
CH12	120	12.2	6-65	6-50	3-50	18-70	18-60	9-60
CH13	150	15.3	8-65	8-50	4-50	24-70	24-60	12-60
CH14	180	18.4	8-65	8-65	4-65	24-80	24-70	12-70

Figure 7-22. CHS/AS and CES FUSES and CONTACTORS

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-22-					CHS/AS and CES Fuses/Contactors	X
1	P	759746	001		CONTACTOR, 40 A, 120 V, 3 Pole	A/R
	P	759747	001		CONTACTOR, 50 A, 120 V, 3 Pole	A/R
	P	759748	001		CONTACTOR, 60 A, 120 V, 3 Pole	A/R
	P	764329	105		CONTACTOR, 65 A, 120 V, 3 Pole	A/R
	P	764323	694		CONTACTOR, 75 A, 120 V, 3 Pole	A/R
	P	764323	433	1	CONTACTOR, Fusible, 40 A (Old Style)	A/R
	P	764329	002		CONTACTOR, Fusible, 40 A (New Style)	A/R
	P	764323	434	2	CONTACTOR, Fusible, 50 A (Old Style)	A/R
	P	764329	003		CONTACTOR, Fusible, 50 A (New Style)	A/R
2	P	150474	521		FUSEBLOCK, 0-60 A, 600 V	A/R
	P	764325	572		FUSEBLOCK, 61-100 A, 600 V	A/R
3	P	764317	820		FUSE, 40 A, 600 V, 5-1/2" Long (Box of 10)	A/R
	P	764323	441		FUSE, 45 A, 600 V, 5-1/2" Long	A/R
	P	764323	434		FUSE, 50 A, 600 V, 5-1/2" Long	A/R
	P	764328	997	3	FUSE, 50 A, 600 V, 2-3/8" Long	A/R
	P	764323	443		FUSE, 60 A, 600 V, 5-1/2" Long	A/R
	P	764328	998	3	FUSE, 60 A, 600 V, 2-3/8" Long	A/R
	P	764325	570		FUSE, 70 A, 600 V, 4-5/8" Long	A/R
	P	764325	571		FUSE, 80 A, 600 V, 4-5/8" Long	A/R

1. *This fusible contactor is NLA; use substitue fusible contactor P-764329-002. When using substitute contactor, it will be necessary to replace the existing fuse; use P-764328-997 (50A) or P-764328-998 (60 A).*
2. *This fusible contactor is NLA; use substitue fusible contactor P-764329-003. When using substitute contactor, it will be necessary to replace existing fuses; use P-764328-997 (50 A) or P-764328-998 (60 A).*
3. *Fuse **ONLY** for use with fusible-type contactors P-764329-002 and 764329-003.*

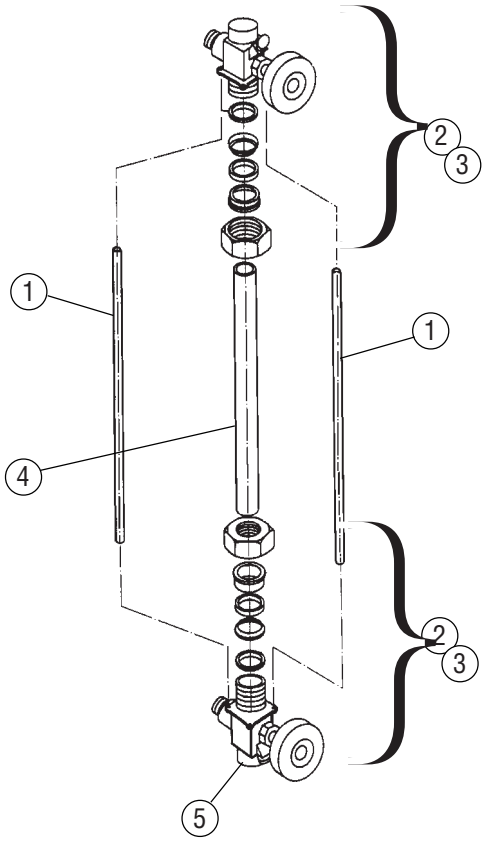


Figure 7-23. CES and CHS WATER LEVEL SIGHT GLASS ASSEMBLY

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-23-					CES and CHS Water Level Sight Glass Assembly	X
1	P	764323	327		ROD, Guard, 7 Lg. (ea)	4
	P	764325	502		ROD, Guard, 7-1/4 Lg. (ea.)	4
	P	764323	700		ROD, Guard, 9-1/4 Lg. (ea)	4
	P	764325	499		ROD, Guard, 10-1/4 Lg. (ea)	4
	P	764323	452		ROD, Guard, 11-1/4 Lg. (ea)	4
	P	764325	500		ROD, Guard 12-1/4 Lg. (ea)	4
	P	764323	453		ROD, Guard 13-1/4 Lg. (ea)	4
	P	764325	501		ROD, Guard 14-1/4 Lg. (ea)	4
2	P	764323	512		VALVE SET, Top and Bottom (brass)	1
	P	764320	900		• VALVE, Top	1
	P	764320	899		• VALVE, Bottom	1
	P	764322	052		• SEAL, Teflon Hyplon	A/R
	P	764326	231		• SEAL, Teflon (Set of 2)	A/R
	P	764326	712		• VALVE, Drain	1
	P	764326	361		• Washer, Stainless Steel	2
	P	764328	203		• KIT, Repair, Valve	A/R
3	P	764315	523		VALVE SET, Top and Bottom (Stainless Steel)	1
	P	764328	618		• VALVE, Top	1
	P	764328	619		• VALVE, Bottom	1
	P	764322	052		• SEAL, Teflon Hyplon	A/R
	P	764326	231		• SEAL, Teflon (Set of 2)	A/R
	P	764326	296		• VALVE, Drain	1
	P	764326	361		• WASHER, Stainless Steel	2
	P	764328	202		• KIT, Repair, Valve	A/R
4	*				KITS, Sight Glass	A/R
					Each kit contains two glasses and eight washers, four of P-751847-091 for round type valve bodies, and two sets of P-764326-231 for square type valve bodies:	
	P	764321	544		• 4-11/16"	
	P	764323	880		• 5-1/2"	
	P	200000	081		• 5-7/8"	
	P	764324	699		• 6"	
	P	764321	195		• 6-1/4"	
	P	764323	543		• 6-1/2"	
	P	200000	136		• 6-5/8"	
	P	764328	920		• 6-3/4"	
	P	764324	885		• 7"	
	P	764323	948		• 7-1/4"	
	P	764322	879		• 7-1/2"	
	P	764323	456		• 7-3/4"	
	P	754031	091		• 8"	
	P	764324	697		• 8-1/2"	
	P	764324	700		• 9"	
	P	764325	491		• 9-1/8"	
	P	764321	717		• 9-1/2"	
	P	764323	457		• 9-3/4"	
	P	754032	091		• 10"	
	P	764323	458		• 10-1/4"	
	P	764329	913		• 10-1/2"	
	P	764321	716		• 10-3/4"	
	P	764324	701		• 11"	
	P	764325	492		• 11-1/8"	
	P	764325	698		• 11-1/2"	
	P	75424	091		• 12"	

* *To determine the correct length of the sight glass, measure the distance between the centerline of the upper and lower sight glass valve hand wheels and subtract 2".*

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FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
7-23-						
(Cont.)	P	764325	493		• 13-1/8"	
5	P	764326	712		VALVE, Drain	1
	P	764326	296		VALVE, Drain (Stainless Steel)	1

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Section 8: Steam Gun Assembly Installation/Operation/Maintenance Instructions

8.0 INSTALLATION

WARNING–BURN HAZARD: Some parts of this equipment are hot. Always wear protective clothing, gloves, and eye protection when operating this equipment.

CAUTION - Possible Equipment Damage: Shut off steam supply and hot water supply lines before proceeding with installation.

1. Mount manifold securely to the wall through mounting holes provided. Recommended height of mounting holes is approximately 72" (1,829 mm) above the floor.
2. Connect steam line to union provided.
3. Connect hot water line to union provided.

IMPORTANT: A minimum of 40 psig hot water and 60 psig saturated steam pressure is required for satisfactory performance. Optimal pressures are 50 psig water and 80 psig steam. If existing supply pressures are too high, install pressure reducing valves on incoming steam and/or hot water line(s) as required.

8.1 OPERATION

WARNING–BURN HAZARD:HOT PIPES! During this procedure, the boiler piping is hot and water is released under pressure and should be connected to a receiver capable of withstanding 260°F (127°C). To prevent burns, wear protective gear and use caution.

1. Connect high pressure steam hose from steam gun to steam/water outlet on manifold.
2. Connect detergent hose to detergent tank fitting.
3. Affix stainless-steel or nylon brush to end of steam gun. NOTE: Brush used (stainless-steel or nylon) is determined by hardness of surface to be cleaned.
4. Hang steam gun from hook provided on detergent receptacle.
5. Fill detergent tank with appropriate solution.

CAUTION - Possible Equipment Damage: Use liquid detergent only. Water soluble powders may clog steam gun.

6. Open steam valve. Open detergent valve.
7. Depress steam lever. Expect a short burst of water (condensate) prior to receiving steam.
8. Adjust detergent flow by adjusting flow valve.
9. For water rinse: Close detergent control valve. Close manifold steam valve. Open manifold water valve. Press trigger.

8.2 CLEANING

1. Use steam with detergent and brush to soften and remove hardened dirt and stains. Rinse with hot water only.
2. For soft stains and dirt, use hot water with detergent and brush to wash. Rinse with hot water only.

8.3 ILLUSTATED PARTS BREAKDOWN

8.3.1 Chromalox (see Figure 8-1).

8.3.2 Electro-Steam (see Figure 8-2).

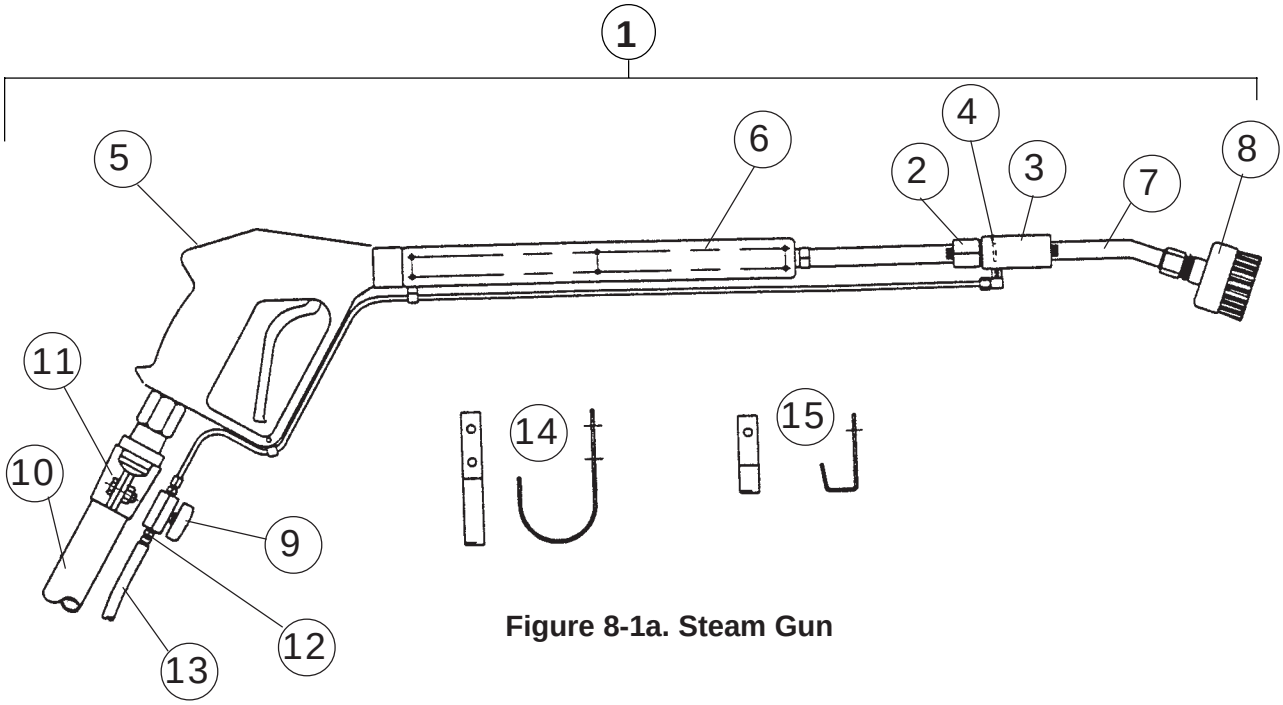

Figure 8-1a. Steam Gun

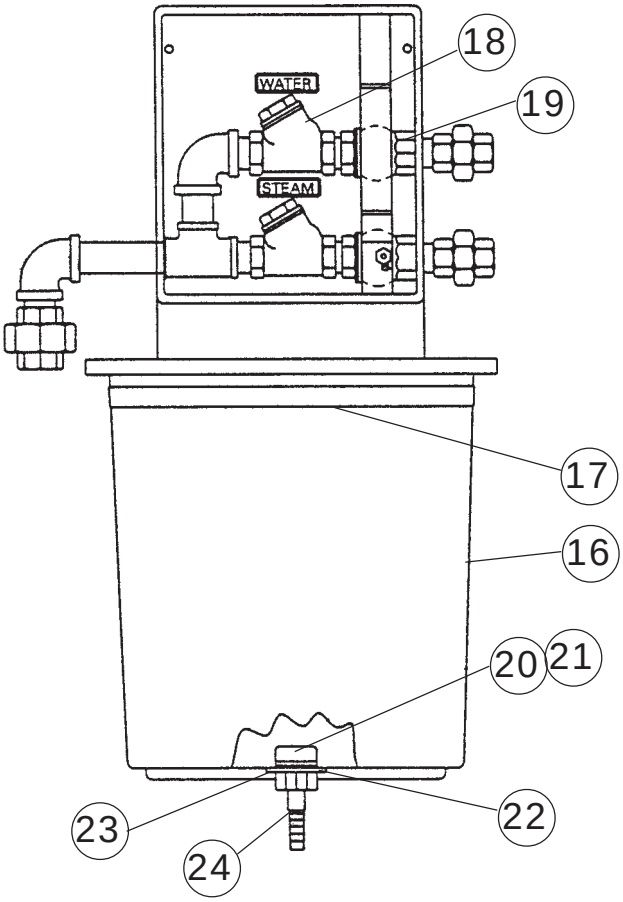

Figure 8-1b. Steam and Water Selector

Figure 8-1. Steam Gun/Steam and Water Selector Manifold (Chromalox).

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY			
8-1-	**P**	**134468**	**994**		**Steam Gun (complete)**	**X**			
	P	**134468**	**995**		**Steam/Water Selector Manifold**		**X**		
1	P	764325	067		STEAM GUN	1			
2	P	764325	068		VENTURI	1			
3	P	764325	069		PUMP	1			
4	P	024684	091		0-RING	1			
5	P	764325	070		HANDLE, Steam Gun	1			
	P	764328	721		• Repair Kit	1			
6	P	764325	071		HANDLE, Wand	1			
7	P	764325	072		EXTENSION, Wand	1			
8	P	764325	073		BRUSH, Nylon	1			
	P	764325	074		BRUSH, Stainless Steel	1			
	P	764325	075		BRUSH, Nylon (2) and Stainless-steel (1) (set of 3)	1			
9	P	764325	076		VALVE, Detergent	1			
10	P	756206	091		HOSE, Steam (with fittings)	A/R			
	P	764319	115		HOSE, Steam (with fittings); 12 ft (3.7 m)	A/R			
	P	764320	949		HOSE, Steam (with fittings); 24 ft (7.3 m)	A/R			
11	P	764317	734		CLAMP, Hose (Steam); 50 ft (15 m)	2			
12	P	756769	091		CLAMP, Hose (Detergent)	2			
13	P	764326	142		HOSE, Detergent (u/m = ft)	A/R			
14	P	764328	904		BRACKET, Steam Hose Support	1			
15	P	764328	905		BRACKET, Steam Gun Handle Support	1			
16	P	764328	702		TANK DETERGENT		1		
17	P	764328	908		BRACKET, Detergent Tank Support		1		
18	P	150822	354		VALVE, Check 1/2"		2		
	P	764319	608		• Disc (Viton)		1		
19	P	764328	230		VALVE, Ball 1/2"		2		
20	P	764328	909		FILTER, Detergent Tank		1		
21	P	764328	910		FITTING, Faucet Adapter		1		
22	P	24684	091		RING		1		
23	P	129353	293		WASHER, Flat		1		
24	P	150474	902		ADAPTER		1		
25	P	756260	091		GLOVES, Pair of (not shown)		1		

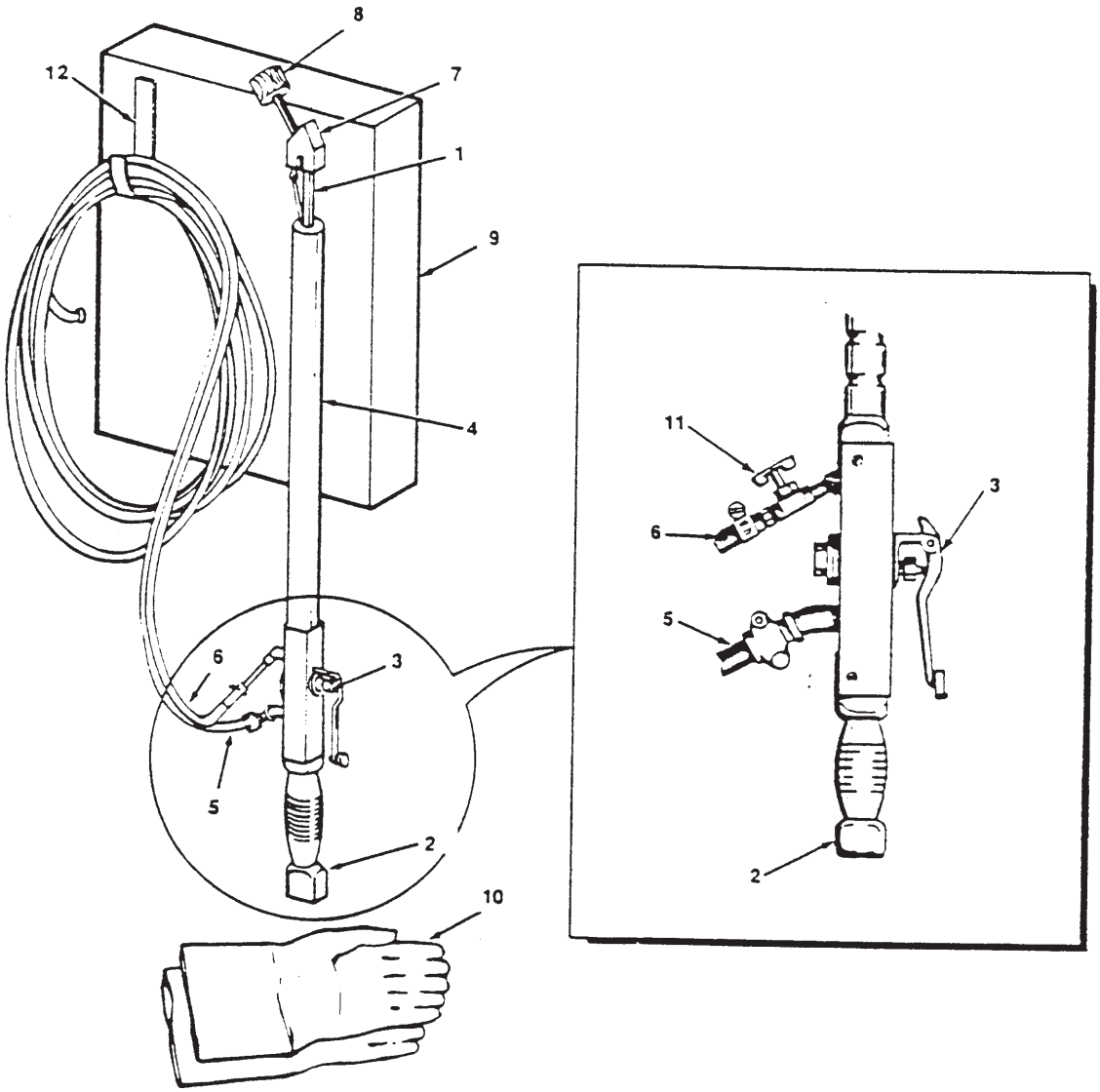

Figure 8-2. Steam Gun/Steam and Water Selector (Electro-Steam).

FIG. & ITEM NO.	PART NUMBER			SVC	DESCRIPTION	UNITS PER ASSEMBLY
8-2-						
1	P	764325	067		STEAM GUN	1
2	P	755715	423		HANDLE, Steam Gun	1
3	P	761602	001		VALVE	1
	P	764315	564		• KIT, Valve Repair	1
	P	764316	264		VALVE, 1/4", Manual Apollo (for Manifold Package) (Not Shown)	1
4	P	758996	001		HANDLE, Tube (9-1/2" Long), w/o inserts	1
	P	764324	716		• Inserts (set of 3)	1
5	P	756206	091		HOSE, Steam (with Fittings), 12'	1
	P	764319	115		HOSE, Steam (with Fittings), 24'	1
	P	764320	949		HOSE, Steam (with Fittings), 50'	1
	P	764317	734		• CLAMP, Hose Steam (for 1/2" I.D. hose)	2
6	P	764326	142		HOSE, Detergent	1
7	P	753505	091		BRUSH HEAD NIPPLE AND MIXING BLOCK	1
8	P	764325	074		BRUSHES, Set of Three Stainless-steel	1
	P	764325	073		BRUSHES, Set of Three Nylon	1
	P	764325	075		BRUSHES, Set of Two Nylon and One Stainless-steel	1
9	P	751210	091		TANK, Detergent	1
10	P	756260	091		GLOVES, Pair of	1
11	P	764325	076		VALVE, Detergent	1
12	P	764320	455		HOOK, Hose	1
13	P	764322	013		STEAM/WATER MIX MANIFOLD w/cover (Not Shown)	1

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